Bulletin 250
of the
Agricultural Extension Service, The Ohio State University

Grape Growing in Ohio

Prepared by the
Departments of Horticulture, Entomology, and Botany
The Ohio State University

Contents

MAY, 1944

OHIO STATE UNIVERSITY AND THE UNITED STATES DEPARTMENT OF AGRICULTURE, COOPERATING
AGRICULTURAL EXTENSION SERVICE, H. C. RAMSOWER, *Director*, Columbus, Ohio
Printed and distributed in furtherance of Acts of May 8 and June 30, 1914

Grape Growing in Ohio

By Frank H. Beach
Extension Horticulturist, The Ohio State University

The early history of grape growing in Ohio is interwoven with the influence of Nicholas Longworth of Cincinnati (1783-1863), the "father of American grape culture." His first efforts to make the Ohio river the Rhine of America" failed, because he used varieties of the European grape *Vitis vinifera)* unadapted to this climate. In 1825 he obtained the Catawba ariety of American grape from Major John Adlum of the District of Columbia. his variety flourished. Plantings were extensive, and by 1859 Ohio led all tates in grape and wine production, most of which was produced in the Cinnati area.

Black rot and mildew entered the picture in those days before the advent f spraying, and this unknown "sickness of the vine" caused the industry to ecline rapidly to minor proportions through southern Ohio. It was learned hat the climate of northern Ohio was more favorable and the industry shifted apidly to this region. Plantings along the shores of Lake Erie and on Lake rie islands were made so rapidly from 1860 to 1870 that it was referred to as he "grape fever." Ohio reached its peak of grape acreage about 1890. California, New York, and Michigan assumed greater and greater importance as grape growing states, and today Ohio ranks fourth.

Commercial grape growing, with its processing and wine industries, lusters along the southern shore of Lake Erie, principally in Ashtabula, Lorain, Lake, Cuyahoga, Erie, Geauga, and Ottawa counties in the order named (see Figure 1). Most vineyards are located on the lake plains and on the two or more ow sand and gravel ridges paralleling the lake shore and closely adjacent to it, ast and west of Cleveland.

About 80 per cent of the grapes grown in Ohio are Concord. East of Clevend the percentage is higher. In Ottawa and Erie counties and on adjacent slands where the growing season approaches 200 days, the Catawba variety predominates and ranks second in Ohio with about 10 per cent of the grape acreage. Niagara ranks third (2.5 per cent), Delaware fourth (2.0 per cent), Ives fifth (1.5 per cent), Worden sixth (1.25 per cent), and a number of other varieties re grown in a limited way to make up the remaining 2.75 per cent of the total 2,000 acres.

Grape Outlook in Ohio

Recent figures have shown Ohio grape production to range from 16,000 to 5,000 tons, although in 1932 it reached 33,600 tons. From 1930 to 1940 there was a decrease in the number of Ohio grapevines. Bearing vines dropped from 8,738,560 to 8,136,915, and non-bearing vines decreased from 814,362 to 345,362. The readjustment was due to low net returns per ton and to increasing difficulty in controlling the major pest, the grape berry-moth.

Many commercial vineyards in Ohio have not been receiving proper spraying, fertilization, and soil management. As a result, the average yield for the State now stands at between 1½ and 2 tons per acre. A vineyard planted to a heavy yielding variety such as Concord should produce at least 2½ tons, preferably 4 to 6 tons or more, to the acre to make the business a worthwhile venture. Yields with Catawba and Delaware are more apt to run from ¾ to 1½ tons per acre, but the price per ton is usually twice or more than for Concord. The recent price range is shown in the following table.

RECENT PRICES TO GROWERS

Year	*Concord*	*Catawba*	*Delaware*
1943.....	$85.00 (Fresh grape ceiling price)	$180.00*	$200.00*
1942.....	55.00	90.00	120.00
1941.....	40.00	75.00	110.00

* No price ceiling established as of May, 1944.

From 1932 to 1940 the price for Concord ranged from $18.00 to $50.00 per ton, while for Catawba the price ranged from $38.00 to $65.00 per ton.

Indications are that World War II will bring a brighter outlook for the grape industry not only in Ohio but for the country as a whole. Consumer purchasing power is on a high level, at least temporarily. Prices and demand for fresh and processed grapes, for juice and for wine, have shown a marked increase. Of particular interest is the greater demand for domestic wines, as influenced by the war rationing of liquor and the great decrease in supply of imported wines. This demand for domestic wines, no doubt, will continue after the war and more attention could be directed toward supplying it. At present, there appears to be a shortage of varieties such as Delaware and Catawba, which are used in making high-grade light wines and champagnes. Most of the 500,000 gallons of wine manufactured annually in Ohio is from the Concord variety. But this does not alone satisfy the Ohio consumption of wine, which is over 3,000,000 gallons per year. Majority of the imported wine comes from California.

It is estimated that 15,000 tons of Ohio grapes are shipped annually to grape juice factories in Pennsylvania and New York. Hence, Ohio has sufficient grapes available to manufacture 3,000,000 gallons of juice annually, but there is not a single juice plant in the State.

THE VINEYARD LOCATION

The three natural factors which largely govern where a vineyard may be properly located are climate, site, and soil.

Climate.—The number of days required for proper maturity of wood and fruit of the grape varies with the variety. Most varieties require more than 160 days from the last frost in spring until the first frost in autumn. Figure 1 shows the approximate boundaries of regions in Ohio which range in growing season from 150 to 192 days. Longest growing seasons are located near Cincinnati and along the shores and on the islands of Lake Erie. It is in these regions,

especially along the shores of Lake Erie, where long-season varieties such as Catawba are more likely to succeed. Concord, on the other hand, requires fewer days for maturity. This variety is generally successful when the average length of the growing season is 170 days, of doubtful success at 157 days, and generally unsuccessful at 145 days. Commercial plantings of grapes should be confined to favorable sites in recognized and established areas in the State.

Site.—In Ohio, there are many small vineyards outside the commercial regions which supply grapes for local market and for home use. If the climate for a particular region is doubtful for grapes, special attention should be given to selection of a frost-free site, and the use of adapted varieties. Since cold air settles to low areas, the vineyard should be somewhat above the surrounding

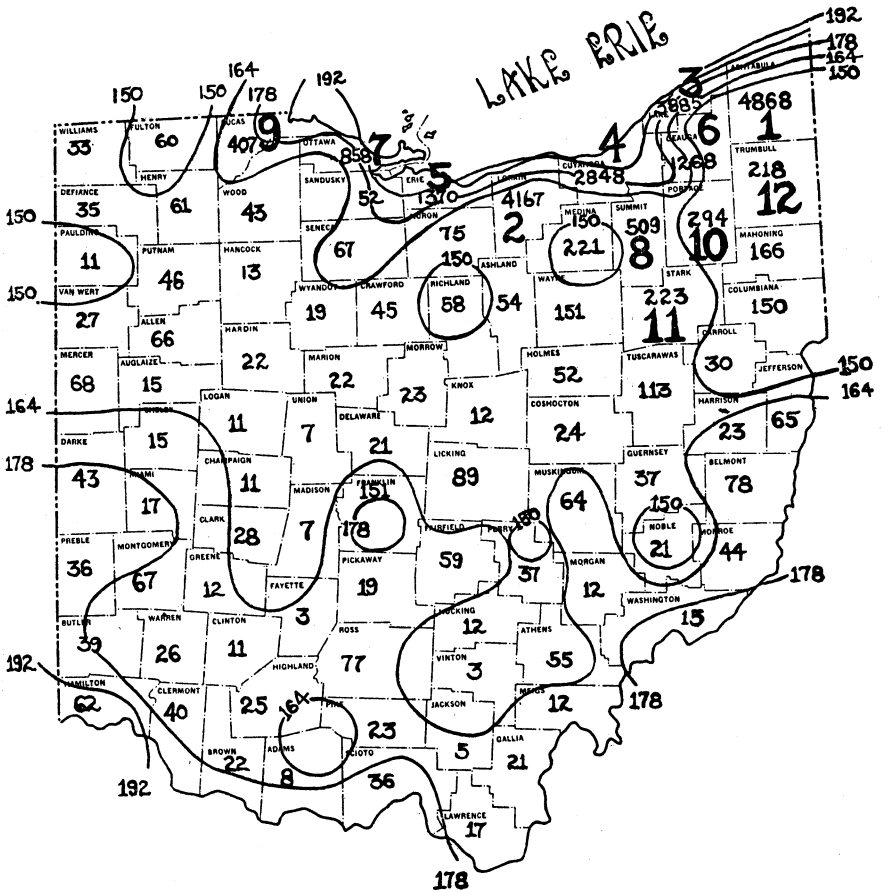


Fig. 1.—Majority of grapes in Ohio are produced along the shores and on the islands of Lake Erie where the growing season is relatively long.

The large numbers in upper right corner of map show rank of counties in grape production in the full-crop year of 1940, according to United States Census. Small numbers in counties show production in tons. Numbers at the end of lines and in circles indicate days between last frost in spring and first frost in autumn. A growing season of less than 160 days is undesirable for most varieties of grapes.

country. The ground may be almost level provided there is opportunity for cold air to drain on one or two sides. There appears to be no advantage in having the land slope in a particular direction. Steep land is undesirable, due to erosion. Site is of less importance within a few miles of Lake Erie, where the air is tempered by the vast expanse of lake water.

Soil.—The best vineyards in Ohio are growing on moderately fertile, well drained sandy or gravelly loam (4 to 6 feet rooting area) which contains a good supply of organic matter. Grapes will grow on a wide variety of soils, including the heavy clays, provided they contain plenty of organic matter and are well drained. In general, the lighter sandy type of soils promote earlier ripening and higher sugar content of the grapes than do heavier soils.

Selection of Varieties

Only those varieties should be planted in a commercial vineyard that have proven their value over many varied seasons. They should be adapted to the region and be in demand for several purposes on the market. The catalogues are carrying several promising new varieties of grapes which should be tried, first on a small scale, before considering them for commercial use. The American type of grape, or its proven hybrids with the European grape, are best adapted to Ohio conditions. With demand increasing from wineries, there is a trend to plant more varieties best suited for wine, as Catawba, Delaware, and Niagara. While more wine is made in Ohio from Concord than from any other variety, Concord is best suited for unfermented grape juice, processed grape products, and in a limited way for the table grape trade.

Following is a brief description of varieties adapted to planting in Ohio, listed in order of ripening.

For Commercial Planting

Fredonia is a blue grape with attractive bloom which ripens 3 weeks before Concord. The bunch resembles Concord but the berries are larger, more compact, and the juice is a deeper red. The vines are hardy, very vigorous, and more productive than Concord. The variety has been sufficiently tried for commercial planting where an early blue grape is desired. The berries are apt to shatter from the bunch unless marketed within 4 or 5 days after picking.

Niagara is the standard white grape with large, compact bunches of high quality, moderately large, yellow-green berries. The variety yields well on a wide variety of soils and is hardy in all but the very severe winters. Since white grapes are limited in demand on most markets, this variety should be planted in amounts to suit local requirements. Niagara should not be harvested until fully mature, as the berries will not continue to ripen after picking. The vines are relatively tender to winter cold and the fruit and leaves are more susceptible to fungous diseases than are those of Concord.

Delaware is a standard, red, mid-season variety. It is hardy and is considered the highest quality American table grape. It ships and stores well. In addition to being a fine juice variety, Delaware serves equally well in wine making and in blending for champagnes. The bunches and berries are small, as are the vines which should be planted closer in the rows than most grapes

(about 8 feet). Delaware is a slow-growing grape and requires good soil management and fertilization with relatively close pruning.

Concord is the standard blue grape in Ohio and leads all other varieties in acreage. It succeeds under a wide variety of soil and climatic conditions. The vine is vigorous, hardy, highly productive, and fairly resistant to attacks of insects and diseases. The fruit ripens evenly, stands reasonable shipment and storage, and is highly prized for juice, jelly, and table use. It is widely used in dry table wines. While Concord can be used for several purposes, there is a trend toward replacing it with varieties better suited for a particular demand.

Catawba is a red grape which succeeds best in the Sandusky area along the shores and on the islands of Lake Erie. About 50 per cent of the grapes grown west of Cleveland are Catawba. It is second to Concord in importance in Ohio. At Wooster and Columbus and most other sections of the State, it does not develop its maximum quality. The berries and bunches are of medium size, ship well, and can be stored under proper conditions until almost midwinter. The vines are fairly productive and hardy, medium in vigor, but the foliage and fruit are relatively susceptible to fungous diseases. It should be pruned closer than Concord. Catawba is a fine table grape when picked fully ripe. Its important outlet, however, is for a high-grade white wine which is used as a base for champagne. It is also excellent for unfermented grape juice.

For Home and Trial Planting

Portland is a high quality white grape which ripens about 3 weeks before Niagara. The vines are hardy, vigorous, and productive. The fruit is moderately tender in flesh and of pleasing flavor. It is necessary to harvest the bunches as soon as ripe, as the berries tend to shatter and lose quality.

Ontario is an early, golden yellow, high quality grape which is good for local markets in addition to being a good white wine grape. The berries are smaller than those of Portland but yields usually are higher. Ontario is a promising variety for regions near Lake Erie, but its planting elsewhere in Ohio is of doubtful value. It should be pruned shorter than Concord.

Worden is a high quality blue variety, which is adapted to home plantings. It ripens unevenly, and the berries may shatter and crack before fully matured.

Captivator is a fairly hardy red grape of excellent quality, adapted only to home plantings.

Golden Muscat is a yellow hybrid grape which has many characteristics of the European type grape. It is suggested only for trial for home and roadside markets in those regions where the growing season is long. The vines have killed to the ground in severe winters at the Ohio Agricultural Experiment Station. It has a tendency to over-produce some years, which weakens the vines.

Sheridan is a high quality blue grape, ripening a week to 10 days after Concord. The berries are large, very sweet, keep well in storage, but tend to ripen somewhat unevenly. The vines are vigorous, fairly hardy, but relatively susceptible to insects and diseases. Sheridan is a new variety adapted to a long growing season and should be planted for trial in regions where there is little danger of early frost.

Cuttings.—The common method for propagating grapes is by cuttings. The process is simple, and if time permits can be done by the grower or home gardener as well as the nurseryman.

Cuttings are made from dormant canes of last year's growth. Select canes about ¼ inch in diameter, well matured, rather short jointed. The best time to secure cuttings is in early winter, soon after the wood is thoroughly dormant. As shown in Fig. 2, each cutting has three buds, with the lower cut immediately below the lowest bud, and the upper cut an inch or two above the third bud. Cuttings average 8 to 10 inches in length. They are usually tied with jute or

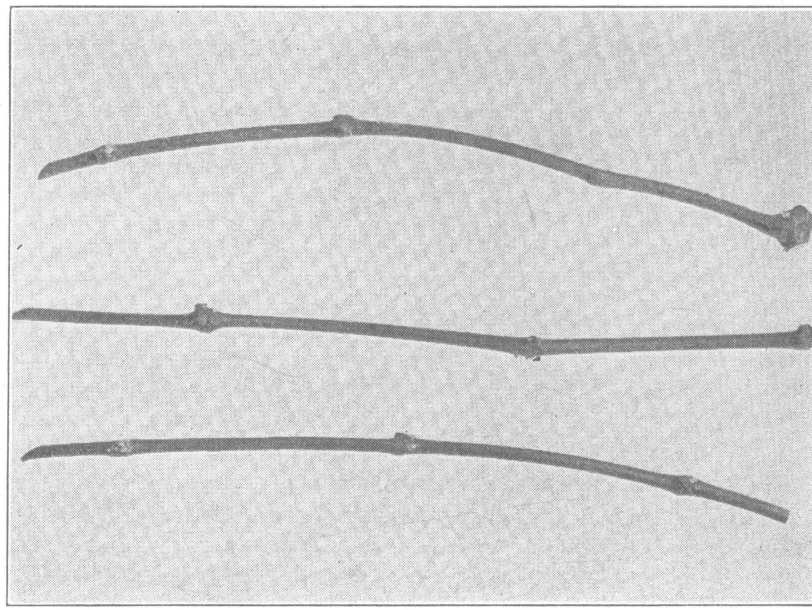


Fig. 2.—Grape cuttings for propagating new vines: Upper cane, mallet cutting, is frequently used, consisting of current season cane with small section of 2-year wood at base. Center cane (most common), lower cut is made just below the eye at a node and upper cut is made about 2 inches above third node. Lower cane, cuts are improperly made.

binder twine in bundles of 25, and buried base side up in a trench located in well drained soil. The butts are covered with about 3 inches of soil. A covering of 6 inches of manure or straw will help protect the cuttings during the cold weather and aid in callusing the butt ends while the tops remain dormant.

In early spring, cuttings are removed, separated, and lined out about 6 inches apart in rows 3 feet apart. Thoroughly firm each cutting in the soil and plant with the top bud of the cutting just above the surface of soil. A well prepared planting bed is desirable, so that soil will be fine and friable and can be firmed around the cuttings. The planting needs frequent shallow cultivation and hand hoeing in the rows to encourage best growth. A 50 to 60 per cent stand is the average experience.

The following spring, the plants are ready to dig and set. The larger No. 1 plants are most satisfactory. Best plants are grown on well drained sandy or gravelly soils which encourage development of an extensive root system.

Layering.—The principal value of layering is to replace missing vines in the vineyard. The plants started by this method in an established vineyard grow faster than 1-year plants secured from a nursery.

As shown in Fig. 3, a vigorous cane from the nearest vine is bent to the ground at the place where the new vine is desired. It is covered with 3 to 4 inches of soil at this point. About three buds are left exposed beyond the point of layering. The best single shoot is trained to form the trunk of the new vine. The nurse cane should be left attached to the young plant for 2 or 3 years until it is thoroughly established before pruning it away from the mother plant.

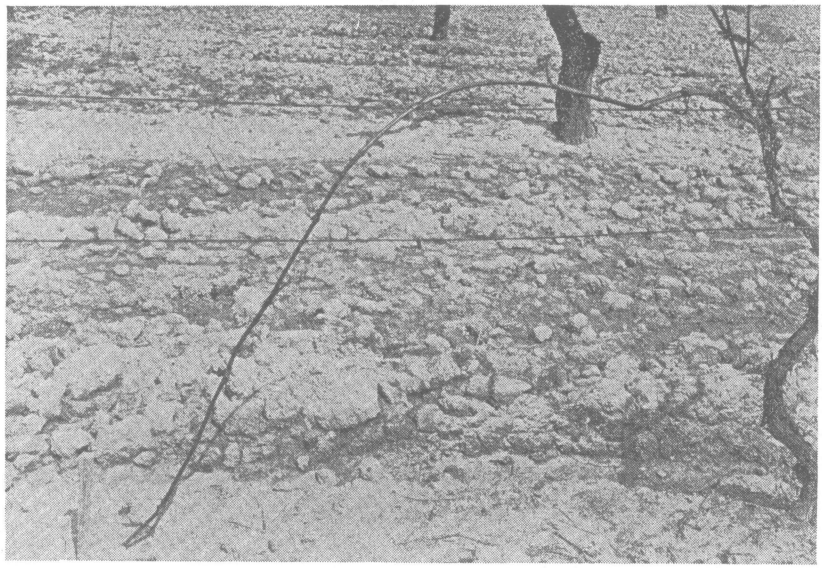


Fig. 3.—Common method for replacing missing vines in a vineyard is to layer a vigorous cane from neighboring vine. The method is simple and effective.

Grafting.—Many varieties of American grapes are improved by grafting on vigorous congenial root stocks. Weak growing varieties, such as Delaware and Catawba, have been strikingly benefited, making more growth and producing more fruit of better quality, than where grown on their own roots. At present, there is insufficient evidence in Ohio vineyards to point out the relative advantages of the grafted vineyard. The supply of grafted vines is limited, because few nurserymen produce them. More testing is needed in commercial vineyards and with home plantings, since grapes are easily grafted, and tests should be encouraged.

Riparia Gloire has been a promising rootstock for Delaware and Concord. Clinton has been very satisfactory for Catawba and Niagara. Cuttings of 1-year-

old rooted plants may be grafted, using the common whip graft. Established vines can be cleft grafted in early spring. The cleft graft should not be waxed, as this will "drown" the scion. Soil is mounded around and over the graft to provide protection and allow for drainage. If further information is desired on grafting grapes write the Department of Horticulture, Ohio State University, Columbus 10, Ohio.

Fig. 4.—On rolling land there is opportunity for surface erosion in spite of good cultural management. If the vineyard is planted on the contour, as above, erosion is reduced to a minimum and considerably more rainfall is retained in the vineyard.

THE VINEYARD

Soil Preparation and Planting

Nursery Stock.—One-year No. 1 grade plants with a well developed root system are most satisfactory for planting. Most grape growers secure their planting stock from nearby reputable nurserymen rather than to attempt to grow their own plants from cuttings. Two-year plants are often unsatisfactory. They may have been weak plants the first year, reset and grown another year to obtain salable size, or else overgrown stock that does not plant as readily as well grown 1-year plants.

Plant as soon as possible after nursery stock is received. If plants arrive in somewhat dry condition, they can be plumped by soaking in water for several hours before planting or heeling-in. Early spring planting is recommended. If the plants arrive before convenient planting time, they should be heeled-in immediately on a well drained site, preferably near the north side of a building. Prepare a furrow deep enough to accommodate the roots. Untie the bundles, separate the plants, and distribute them along the furrow. Sift the soil among

the roots so that there are no large air spaces. Cover thoroughly with soil and tamp it well. Cover most of the tops with soil, and, as a final precaution, cover tops with wet burlap or moist soil to help keep plants dormant in case the weather suddenly turns warm.

Preparation of Soil for Planting.—Plow and harrow soil for early spring planting. Sod land to be used for vineyard should be planted to a cultivated crop for at least a year before setting the vines. Where available, an application up to 6 to 8 tons per acre of barnyard manure before plowing is recommended to improve growth of both vines and cover crops. Where slopes are involved that would erode under cultivation, contour planting should be followed, if possible (see Fig. 4). Grape rows must be cultivated in a commercial vineyard, so every precaution should be given to avoid soil erosion losses.

Planting.—The row can be lined out with a 3-foot guide stake at each end and as many stakes in between as are needed. A straight furrow can be plowed along this row line. After row lines have been plowed out, heavy chains or other suitable markers can be dragged at right angles across the furrows to mark the point where each plant can be set. The planting distances will vary with the variety and type of soil. Vigorous varieties, such as Concord, Niagara, Fredonia, and Sheridan, should have the rows spaced 10 feet apart with the plants 9 to 10 feet apart in the row. Less vigorous varieties, as Delaware and Catawba, may be set 7 to 8 feet apart in row.

NUMBER OF PLANTS TO ACRE

Planting distances	No. of plants
10 by 10 feet....	434
10 by 9 feet....	484
10 by 8 feet....	544

It is usually desirable to have the rows at least 10 feet apart to allow room for spraying with tractor and for convenient hauling at harvest. With commercial vineyards, which are 5 or more acres in size, alleys wide enough to permit turning with a tractor should be provided at intervals of 300 to 400 feet. These alleys facilitate cultivation, spraying, collection of prunings, and provide for shorter hauls during the picking season.

Prune and plant the vines as suggested in Fig. 5. Prune roots very little, only enough to cut away broken portions and ragged ends. Place and arrange roots well in hole, firming soil around and over them. Top is cut back after planting to two buds on best single stem.

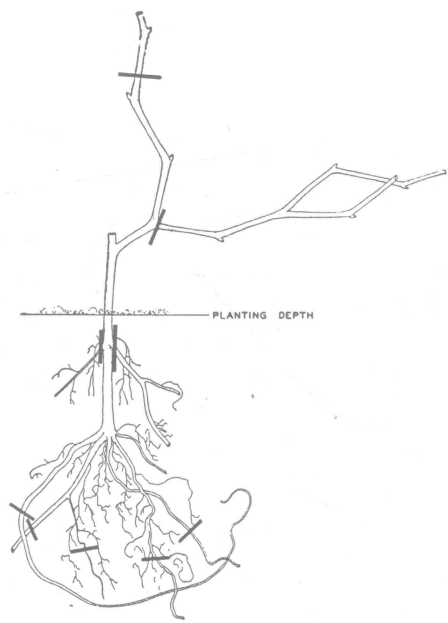


Fig. 5.—One-year grape plant pruned to two buds at planting time. The roots and top are pruned as shown by the black marks.

Cultivation

Growth and yields are improved by frequent, shallow cultivation, beginning in early spring and continued through early summer. It is desirable to begin the spring cultivation just as early as the soil can be worked. Where an over-wintering cover crop, such as rye (see Fig. 6), has been grown, the soil should

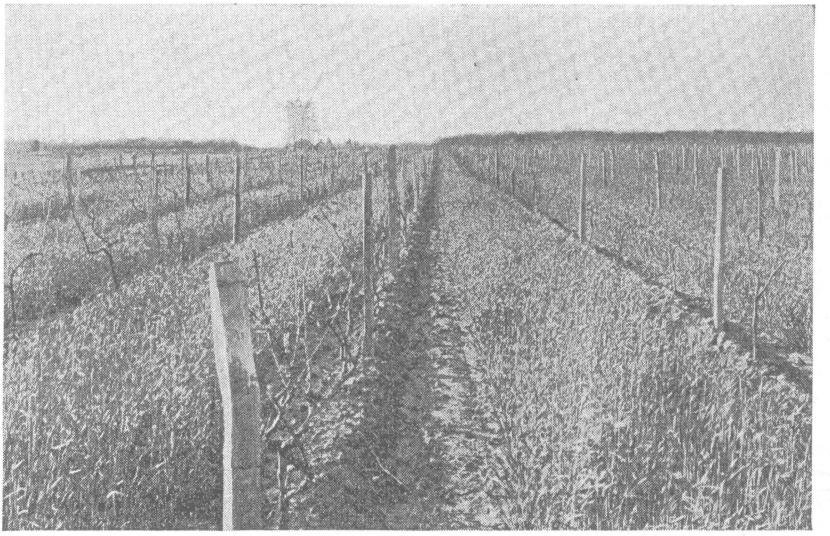


Fig. 6.—The rye cover crop should be turned under in early spring while still leafy and before it has jointed when no more than knee-high. Initial step is to throw the soil toward the vines with a plow or horse hoe, covering any over-wintering berry moth cocoons. Remaining rye is turned under by shallow plowing or double disking.

be plowed or disked while the rye is leafy and before it has jointed, working it down as a rye sod. Where the vineyard is plowed, it is recommended that plowing be as shallow as possible, not more than 3 inches deep, especially where close to the row, to minimize cutting of grape roots.

Continue cultivations with disk or harrow to kill weeds, prevent soil from baking, and to properly level the vineyard until time for seeding the cover crop (see back cover). On gravelly and sandy soils, the vineyard can be left quite level over winter. On heavier loams and clays where surface drainage is likely to be slow during the winter, it is often desirable to make one or more rounds with the plow or grape hoe (see Fig. 7) or both in late fall, throwing the soil in a ridge under the wires. The ridge should be sufficiently high to provide surface drainage away from the grape row during the winter and prevent heaving damage to the vines.

Where the grape berry worm is a problem, soil thrown toward the vines in the fall under the trellis should be left undisturbed until about a week or 10 days after grapes blossom the following spring, as an aid in smothering over-wintering cocoons, which are often found in large numbers on the old grape leaves

nd other trash under the trellis (see Fig. 24). Where the vineyard has been ft level over winter, a round or two in early spring with the plow or grape oe is recommended to throw the soil toward the vines. This provides a good over of at least 2 inches or more of fine soil to a width of about 18 inches irectly under the trellis. This cover should be left undisturbed until after loom (see Fig. 8).

Whether the soil is thrown under the trellis in the fall or spring depends pon the type of soil and the need for surface drainage during the winter.

Cover Crops

The frequent cultivations recommended for grapes during the spring and rly summer are desirable to promote favorable growing conditions to produce good crop. This cultivation program hastens the decay of organic matter in he soil, and this means a continuous change toward poorer soil tilth and

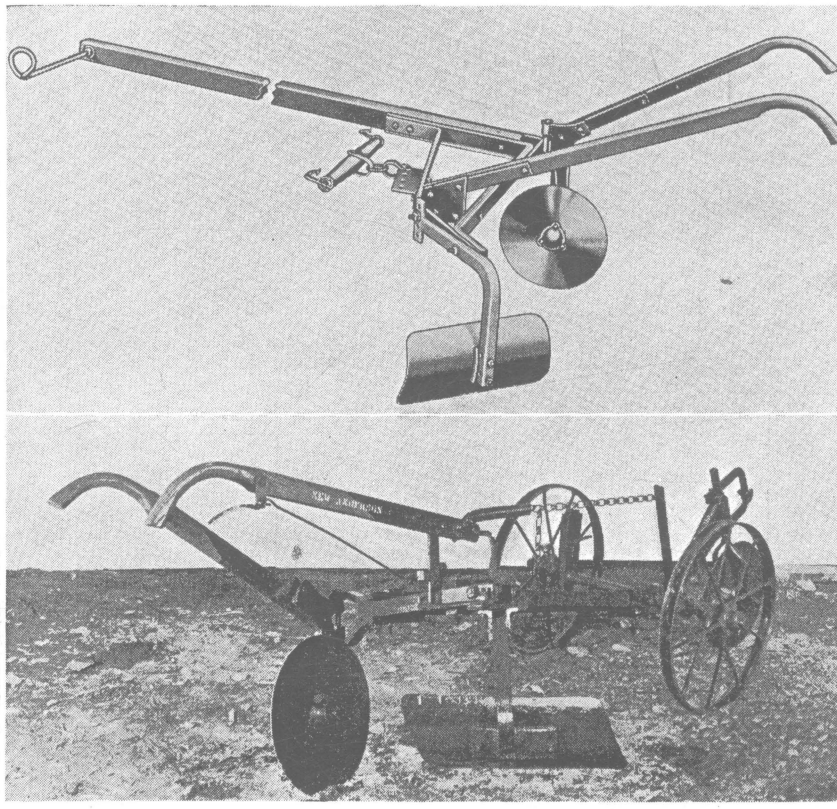


Fig. 7.—(Upper) A type of grape hoe which has been in use for many years, as shown in Fig. 8. The blade may be weighted if it is desirable to cut deeper.

(Lower) The Anderson grape hoe, recently introduced by Ajax Flexible Coupling Company, is particularly effective and easily handled on level ground. Either hoe may be pulled by horse or tractor.

packing unless the program provides some way to maintain needed organic matter from year to year. It is very important, therefore, that good cover crops be grown annually to supply needed organic matter and keep the soil in good workable condition. Cover crops also reduce soil erosion and losses from the leaching of mineral nutrients during the fall and winter. They aid in properly maturing the wood, thus reducing risks from winter injury.

Soybeans, Rye, or Rye Grass.—In young vineyards, two cover crops a year may be grown. Soybeans may be planted about June 1 or about 2 weeks after corn planting time, disked under in late August, and the vineyard seeded immediately to a rye cover crop. After the vineyard has become established in full bearing, a single cover crop, such as rye, sown in early August and turned

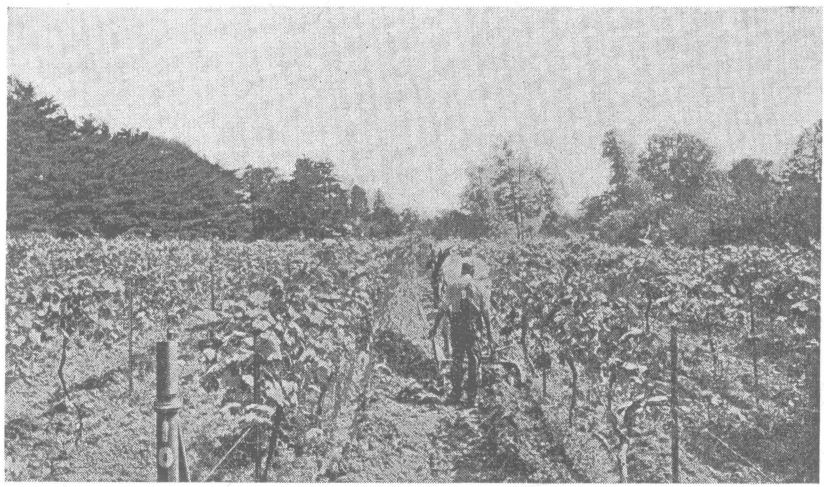


Fig. 8.—The horse hoe is an effective tool for pulling soil and weeds from beneath the trellis, or for throwing soil toward the trellis for purpose of covering grape berry moth cocoons. The implement eliminates much hand hoeing in the vineyard, but it must be used carefully to avoid up-rooting and scarring the vines.

under early the following spring before it is jointed and while still leafy, provides a cover crop which is quite satisfactory for all soils and sites. Another cover crop, worthy of trial, is domestic ryegrass, which can be sown earlier than rye. It makes a larger root system, and can be worked down later in the spring.

It is an advantage to drill over-winter cover crops, such as rye and ryegrass, with a one-horse grain drill to confine the growth of the cover crop to the middles between the rows. This keeps the area beneath the trellis relatively clean of surface trash, which is an aid in control programs for the grape berry-worm. To facilitate grape harvest, the growing cover crop of rye or ryegrass can be flattened with a roller or planker just before the grapes are harvested. Where a cover crop is desired which kills over winter, oats or buckwheat, sown in July or in early August, may be considered.

Liming May Be Necessary.—Before or at the time of seeding the cover crop, apply such amounts of lime as soil analysis[1] or experience indicates will promote the greatest bulk of cover crop growth. Many vineyard soils, especially the heavier soils, are too acid to grow satisfactory cover crops until adequately limed. At the time of seeding or drilling the cover crop, an application of 250 to 300 pounds per acre of a 4-10-6 or similar grade fertilizer is recommended to promote the greatest bulk of cover crop growth. The value of cover crops is determined by the amount of plant growth made by both roots and tops. It is particularly important that an extensive root system be developed by the cover crop.

RATE AND DATES OF SEEDING COVER CROPS FOR GRAPES

Kind	*Rate per Acre*	*Seeding Date*
Soybeans	2 bushels	Early June
*Rye	2 bushels	Early August
*Domestic ryegrass	20 pounds	Early July
Oats	2 bushels	Early August
**Buckwheat	1 bushel	Late June or early July

* Crop lives over winter.
** Will reseed itself second and third year.

Manure and Fertilizers

Manure.—Tests made by the Ohio Agricultural Experiment Station and confirmed by the experiences of many growers have shown that manure is probably the best all-around fertilizer for grapes. Applied during the winter or very early spring at the rate of 6 to 8 tons per acre, manure has often increased yield by about 30 per cent. In most of the commercial grape growing areas of Ohio manure is not available for vineyards, so the grower must rely on commercial fertilizer and soil improving cover crops.

Nitrogen Fertilizers.—Except on exhausted soils, grapes have not responded as readily to nitrogen fertilizer applications as the other fruit crops. Probably, this is due in part to the heavy annual pruning given the grape vines. However, when growth becomes unsatisfactory to support the proper number of buds per vine after pruning, nitrogen fertilizer applications are usually beneficial. Response from nitrogen fertilizer applications comes most quickly on sandy and gravelly soils. On the heavier loams and clays it may require about three years before definite response from the nitrogen fertilizer application is observed. The suggested recommendation is to apply about 300 pounds per acre of nitrate of soda, or about 250 pounds per acre of sulphate of ammonia or cyanamid, or about 150 pounds per acre of ammonium nitrate, making the application either in the late fall or early spring.

The nitrogen fertilizer is usually broadcast in strips on either side of the grape row, while complete fertilizer and lime are applied over the middles of the rows to promote better cover crop growth. Fall applications of nitrogen fertilizer are recommended after grape harvest and before December 1. Cyanamid is preferred as a fall application. The other nitrogen fertilizers are ordinarily used as an early spring application just before or at the time growth

[1] A pint of soil may be sent for free analysis to Department of Agronomy, Townshend Hall, Ohio State University, Columbus 10.

is starting. Continued use of sulphate of ammonia increases soil acidity, which can be corrected by occasional applications of an equal quantity of agricultural limestone.

The Trellis

Most commercial vineyardists do not expect much production until the third growing season. Vines are usually allowed to trail on the ground the first year. However, if companion crops are planted or a reasonable yield is desired the second year, it is an advantage to train the vines to a 4- to 6-foot stake the first year.

Fig. 9.—A satisfactory method for bracing end posts is to use stay posts as shown above. They do not interfere with farm machinery turning at the end of rows, as when brace wires are attached to a "dead man" (log) buried in the ground beyond the end posts.

Following satisfactory vine growth, the trellis should be in place at the beginning of the second season's growth. Where the first-year growth is weak, less than 3 feet, vines can be cut back again as advised at planting time, and then the trellis built to take care of the vines at the beginning of the third season's growth.

Posts.—It is recommended that posts be set from 24 to 30 feet apart with 3 vines between the posts. Distance between the posts will depend on the planting distance between vines in the row—8, 9, or 10 feet. Select posts from durable wood such as white oak, cedar, or locust, preferably creosote treated to prolong their life. There is a growing tendency to use iron or steel posts. While their

nitial cost is higher than wood, they are more durable, and drive and handle n the ground to better advantage. Heavy wooden end posts are preferred, uch as posts 5 to 8 inches in diameter at the top and 9 feet long to permit setting 3 feet deep. Line posts can be somewhat lighter, at least 3 inches in diameter at the top and 8 feet long to permit driving 2 feet in the ground where the Kniffin system of training is used.

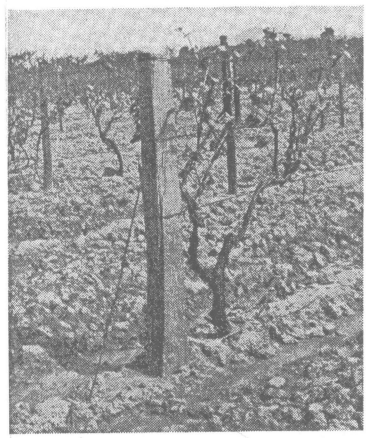


Fig. 10.—End posts may be braced by a wire attached to a "dead man" (log buried in the ground).

For the Fan system of training, posts can be somewhat shorter; 6- to 7-foot posts are often used, driven about 18 inches into the ground. Wooden posts are sharpened and are usually driven into the ground with a heavy maul, while the operator stands on a wagon or truck.

End posts should be well braced to prevent wires from becoming slack. A satisfactory bracing is shown in Fig. 9, where a 4- by 4-inch brace is run from near the top of the end post obliquely ward the ground and fitted against a short post set about 8 feet back in the w from the end post.

A second method of bracing is to carry a brace wire from the top of the d post to a "dead man"—a log buried about 2 feet in the ground beyond e end post as shown in Fig. 10. The objection to this method of bracing is at the brace wire is frequently caught by cultivating tools.

A third method is to t a second post 6 to 8 et back in the row from e end post. A guy wire secured from top of cond post to the base of e end post. A 2- by 4-ch oak brace is placed agonally between these o posts, notched in ace near the top of the d post and at the base the second post, as own in the illustration ig. 11). This type of end post particularly solid.

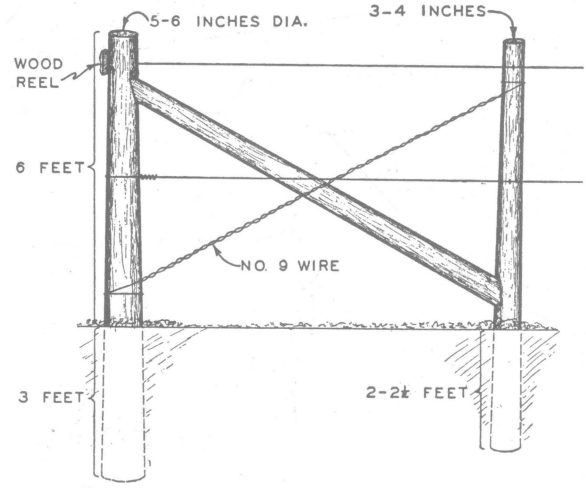


Fig. 11.—End posts braced as shown above are particularly strong. Life of the posts is increased by soaking the lower ends in creosote before setting. A wood reel is shown at upper left which may be used for tightening the wire.

Wires.—For the Kniffin system of training, a two-wire trellis is used, with the upper wire preferably of No. 9 gauge and the lower wire No. 10 gauge. For the Fan system of training, two wires as recommended for the Kniffin system or three wires of No. 10 or 11 gauge may be used. Durable galvanized wire is preferred. The amount of wire needed can be easily calculated from the accompanying table.

Gauge of Wire	*Feet Per Pound*
9	17.05
10	20.57
11	25.82

With the Kniffin system the upper wire is strung at a height of 5½ to 6 feet and the lower wire about 3 feet from the ground. With the Fan system, the lower wire is usually about 24 inches from the ground, a convenient height to tie the Y-arms of the trunk. The two other wires above are spaced from 18 inches to 2 feet apart. Where two wires are used they are strung at heights of about 30 inches and 5 feet, respectively, from the ground. Wires are attached with long staples driven into the posts so that the wire slips, and can be tightened as needed. The wires contract during cold weather and should be loosened in the fall to prevent undue strain on the end posts. In the spring after pruning is completed and before the canes are tied, the posts should be driven down where necessary, and the wires tightened, using a common wire stretcher. Each wire should be fastened securely to the end post, or carried through the end post in a small hole to a wire tightener (2- by 2-inch block of wood acting as a spool) placed at the back of the post. A ratchet type of tightener is often used.

Wires can be tightened, also, by using a wire stretcher midway between end posts and resplicing wire after it is drawn taut.

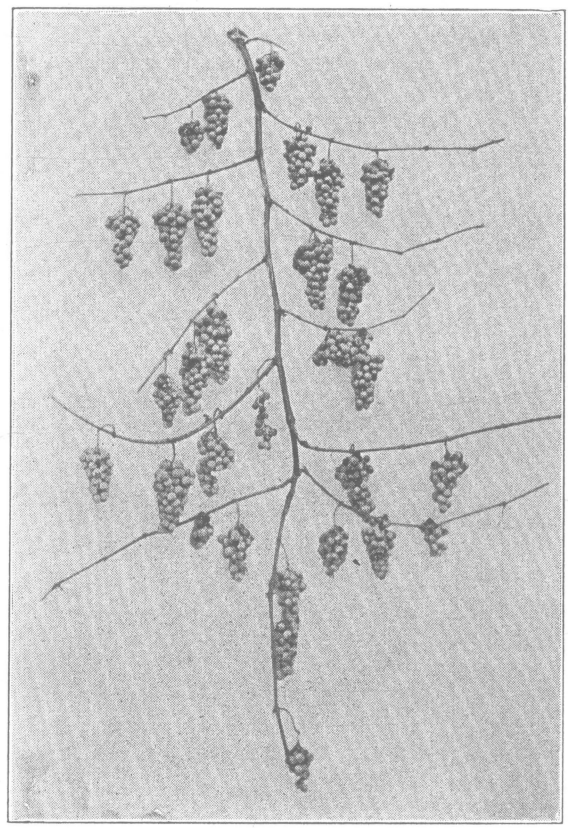


Fig. 12.—A fruiting Catawba cane which shows the location of the best clusters and where the most fruit is produced. The basal and terminal buds are poor producers. The second to fourth buds usually produce the most fruit.

Growth and Fruiting Habits of Vines

Grape clusters are borne laterally near the base of leafy shoots which arise from buds on 1-year-old wood or canes (see Fig. 12). Shoots that arise from wood older than 1 year are usually unproductive or produce grapes of inferior quality. It is important, therefore, that the vines be pruned so that an adequate amount of conveniently placed 1-year-old wood carrying buds is available from year to year near the trunks of the vine for fruit production. An average yield for a vine in good growing condition is about 15 pounds of grapes. A bunch of grapes usually weighs from ¼ to ½ pound. So, from 30 to 60 bunches are needed to produce the 15 pounds of fruit. Since each fruit-bearing shoot produces from one to three bunches, the vine after pruning can produce the 15 pounds easily from 30 buds or less.

The mature grape vine carries a large number of buds before pruning, and, therefore, it is easy to understand why severe annual pruning is necessary to keep an undesirable amount of old wood from accumulating and to select the proper number and length of desirable fruiting canes near the trunk of the vine from year to year. Near the base of each cane, another cane is cut back to a renewal spur.

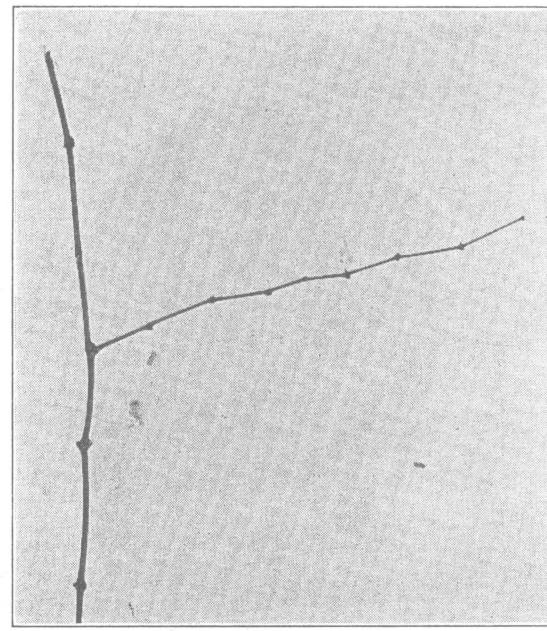


Fig. 13.—An over-vigorous bull cane is shown at the left. The lateral is of medium size and might be retained for fruiting wood in the dormant pruning.

Parts of the Vine Defined

Recommendations for the pruning and training of the grape are better understood if one is familiar with the common terms of the different parts of the vine.

Trunk—The main unbranched stem of the vine.

Arms—Short branches of old wood extending from the trunk.

Old Wood—Parts of the vine older than 1 year.

Shoots—A leafy growth developing from a bud which may support blossoms and later fruit. During the growing season such growths are called shoots. After the leaves have dropped these are called canes.

Canes—The dormant shoots which have become woody and which carry buds or eyes during the dormant season and support shoot growth the following year.

Bull Canes—Excessively large canes with long internodes; buds usually small and unproductive. Laterals from bull canes may be used for fruiting canes (see Fig. 13).

Lateral—The branch of a shoot or cane.

Spur or Renewal Spur—A cane which has been cut back to a short stub carrying one or two buds, and placed to develop a shoot to be used as a fruiting cane the following year (see Fig. 14).

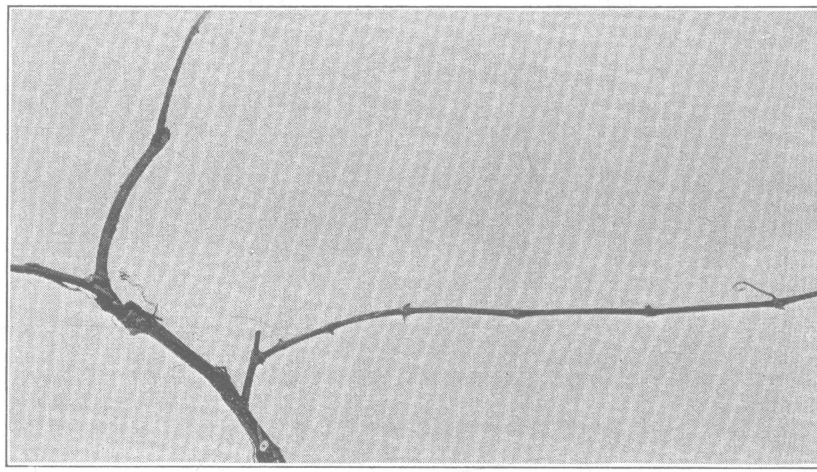


Fig. 14.—The fruiting wood shown at the upper left grew from a cane used for fruiting last year, while the cane at the right arose from last year's renewal spur.

Node—The joint on a shoot or cane where leaves, tendrils, or buds are located.

Internode—The portion of the wood of a shoot or cane between the nodes.

Eye—The compound bud at each node on the cane.

Primary Bud—Largest and most prominent bud of an eye at a node.

Secondary Bud—The smaller buds at a node which often develop if a shoot from the primary bud fails. Such a shoot is less productive than the shoot from a primary bud.

Sucker—A shoot which arises from below the ground.

Water Sprout—A shoot which arises along the trunk or arm.

Season for Pruning

The best time to prune is from the middle of February until buds swell. Canes will "bleed" or exude sap from the cut ends if they are pruned after the sap starts to run and while the buds are swelling. Bleeding annoys the worker but is not serious. Complete the pruning in February, if possible. Never allow the vines to go without annual pruning.

The amount of pruning is adjusted to the vigor of the vine. Fewer canes and buds are left on young or weak vines or on weak canes. If too much cane and bud-carrying wood is left after pruning, the bunches may be small and scraggly, while too heavy pruning reduces yields and promotes excessive wood growth.

No pruning is needed during the growing season, as grapes do not require direct sunlight to develop color. Full growth of healthy leaves will promote the best bunches and quality in the berries. Shoots which tend to grow out of bounds can be tied back to the trellis or arbor during the summer as necessary. Summer tying is not needed with the Kniffin and Munson systems.

Pruning Young Vines

First Year.—After planting, prune off all but the strongest cane. Cut it back to two buds (see Fig. 5). As shoots become woody in early summer, prune to direct the growth into two shoots for the fan system and into the best single shoot for Kniffin and Munson systems, and for arbors.

Second Year.—Remove all but the best single cane for the Kniffin and Munson systems and the best two canes for the Fan system. If the trellis is ready, remove all but the best two canes with the Fan system and tie these obliquely to the first wire and cut the canes back just above the ties. With the Kniffin and Munson systems, prune away all but the best single cane, which is tied securely to the upper wire, loosely to the lower wire, and cut off just above the upper tie. If trellis is not ready, it is best to tie canes to a 4- to 6-foot stake to develop a straight trunk for the

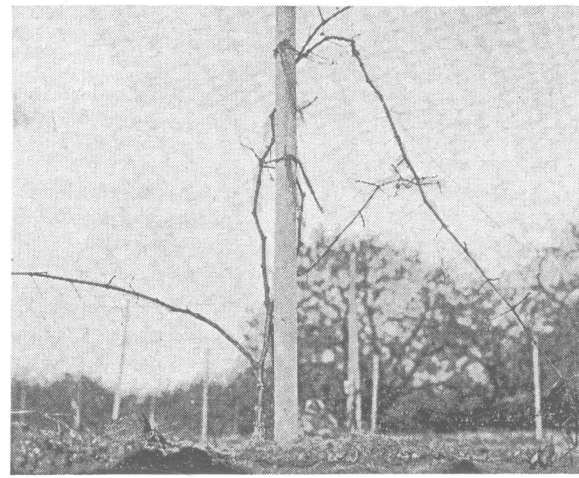


Fig. 15.—Tying the young vine to a stake as shown above aids in producing a straight trunk which greatly facilitates vineyard operations in future years.

Kniffin system or Munson system (see Fig. 15). If the cane growth is weak, less than 3 feet, cut off all but the best single cane and cut this back to two buds as recommended for the first year's pruning at planting.

On arbors, train as advised for the Kniffin system except that the trunk is carried up and over the arbor, using more and shorter fruiting canes (see Fig. 20).

Third Year.—This year, a vigorous vine can carry about 25 buds after pruning. With the Fan system the two canes which were fruited the second year can be cut back to form the Y-trunk from which two canes can be carried obliquely from the lower to the top wire. If available, provide four renewal spurs along the Y-trunk by cutting back other canes to one or two eyes. Prune away surplus canes.

With the Kniffin system, select the best two canes near each wire level and prune away the rest. Leave two renewal spurs on the trunk which have been cut back to one or two eyes at each wire level. Canes can be spiralled around the wire, extending in opposite directions from the trunk and tied loosely to the wires. Canes can be cut to about a six-bud length on the lower wire and to four or five buds on the upper wire. These canes, when cut back the following year, become the arms from which fruiting canes are selected for each wire level in later years.

With the Munson system, two to four canes, each carrying from six to eight buds, can be left after pruning. The canes are trained horizontally in opposite directions from the trunk and wrapped around and tied to the wires with jute twine or small wire. Renewal spurs are left near the base of the canes or trunk and all other surplus growth pruned away. The following year these canes are cut back to short arms extending on either side near the top of the trunk to provide points from which fruiting canes and renewal spurs are selected in later years (see Fig. 19).

With arbors, desirably placed fruiting canes can be cut back to short arms to provide spurs and renewals in later years. Many surplus canes are removed (see Fig. 20).

Pruning Mature Vines

Vines are pruned annually to train the trunk and arms so that the minimum amount of old wood supports the desirable type, length, number, and distribution of canes with renewal spurs provided near the base of fruiting canes to permit renewal of a similar size and type of vine after each annual pruning.

Select fruiting canes of plump, medium-sized wood carrying good buds (see Fig. 16). With Concord, canes which measure ¼ inch in diameter between the fifth and sixth buds have been most productive. Canes with eight to ten buds after pruning are the most desirable length. These should arise as near the trunk of the vine as possible. Near the base of each cane left for fruiting select another cane or two and prune them back to one or two eyes to provide renewal spurs from which to select another fruiting cane at this point next year. Remove all surplus wood, leaving only fruiting canes and spurs. Then tie the fruiting canes to the trellis or arbor with jute twine or light wire, using a loose

tie. With the Fan system or modification of it, a tight tie is used to secure the cane to the upper wire.

Prune each vine according to its age and vigor. Mature, vigorous Concord vines in good vineyards may carry 40 buds or more after pruning, while with weaker growing vines and varieties, half this number of buds may result in better fruiting. In every vineyard there are weak and strong vines, and pruning must be adapted to the vines and also to the individual canes on the vine. The length of cane after pruning is important. Usually the fifth, sixth, and seventh buds, counting from the base of the cane, will develop the most productive shoots and such canes pruned to carry eight to ten buds are very desirable for fruiting.

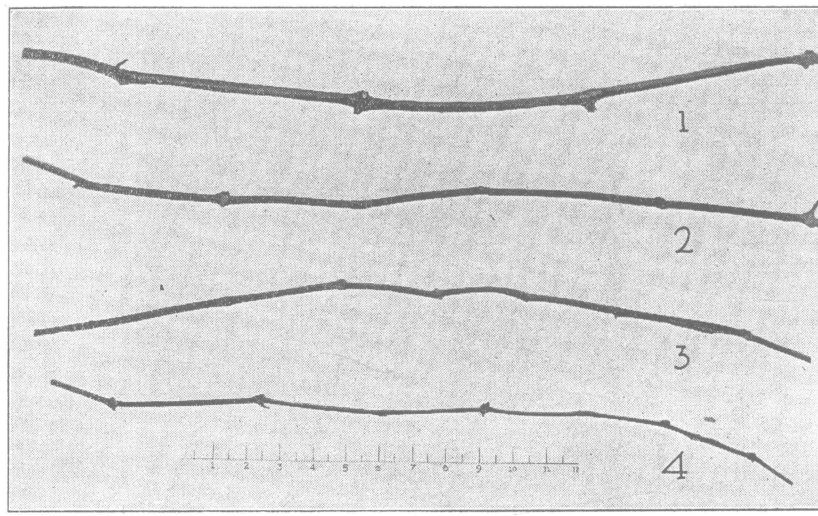


Fig. 16.—Types of fruiting canes: No. 1 is too large; buds are far apart and usually small. Nos. 2 and 3 are canes of intermediate size. No. 3 is particularly good. Notice the short distance between buds while the bud itself is large and plump. No. 4 is too small.

Methods of Training

Fan System. A low headed, well spread Y-trunk with each branch carried up near the level of the lowest wire gives best opportunity for spacing fruiting canes and renewal spurs (see Fig. 18). Usually four canes carrying eight to ten buds are trained obliquely on the wires after pruning, and renewal spurs of one or two buds provided for development of well spaced fruiting canes for the following crop. On very vigorous vines of heavy yielding varieties such as Concord and Niagara an additional cane or two can be cropped. With weak vines, particularly with lighter yielding varieties as Catawba and Delaware, for which this system is well adapted, fewer than four canes may be left after pruning.

Vigorous canes are pruned to carry more buds than the weaker canes. With the Fan system it is necessary to tie back the fruiting shoots to the trellis

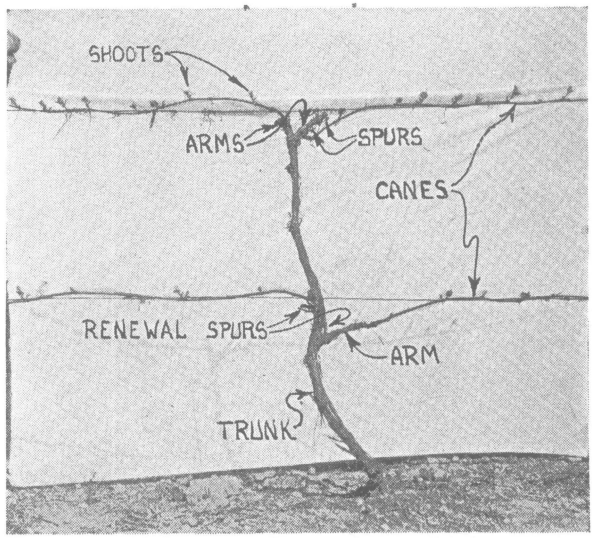


Fig. 17.—The 4-cane single-trunk Kniffin system is well adapted to vigorous varieties of grapes such as Concord, Niagara and Fredonia. The vine is pruned to four canes, totaling about 40 buds. A renewal spur with two buds is left near the base of each cane for purpose of renewing the fruiting wood next year.

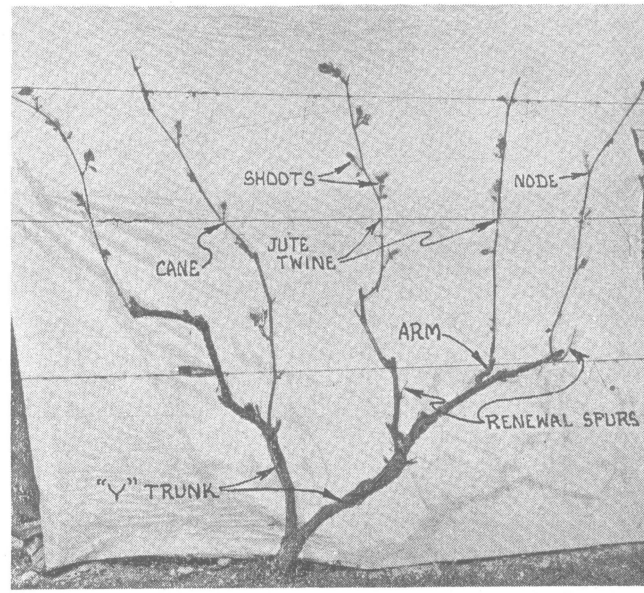


Fig. 18.—Over 90 per cent of the commercial grapes in Ohio are trained by the Modified Fan system. The Y-trunk remains more or less permanent while the canes are renewed each year.

Note that the upper buds are starting first and give promise of making the most vigorous growth.

t 1- to 2-week intervals during the summer, as they droop under weight of ruiting.

Single-Stem Four-Cane Kniffin System.—This system is well adapted to igorous growing varieties with drooping habit of growth such as Concord, redonia, and Niagara. Four canes are selected, one on the right and one on the ft just below the upper wire, and two similarly located canes just below the wer wire level (see Fig. 17). Renewal spurs of one or two buds are provided n the arm or trunk near the base of each cane left for fruiting. The purpose is renew canes at these respective locations for the following crop. All surplus ood is pruned away each year.

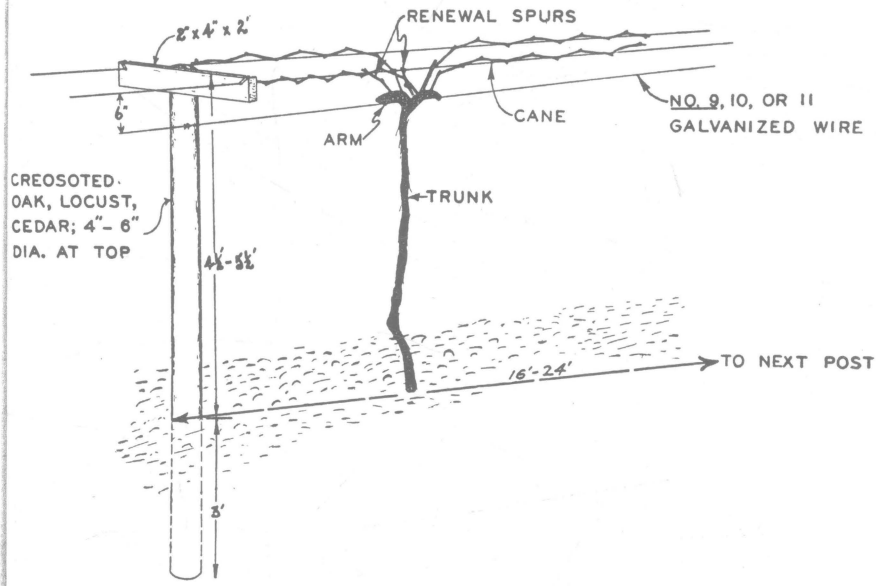
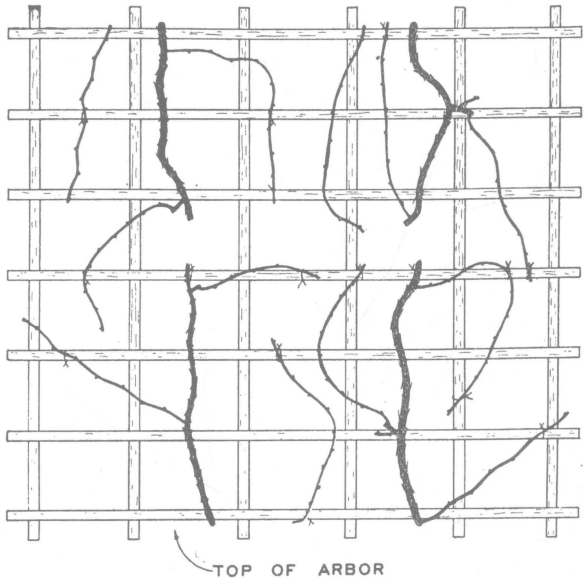


Fig. 19.—A modification of the Munson system of training grapes, as shown above, is convenient for vines growing in the home garden. The worker can move easily from row to row while cultivating or picking the grapes. With no lower leaf surface, leafhopper infestations are reduced and spraying is facilitated.

It is desirable to provide short arms on either side of the trunk just below ch wire level, as canes arising from arms are usually more desirable than those ising from the trunk. The arms provide good opportunity to select renewal urs. No summer tying of the shoots is needed with this system. The bunches d foliage are conveniently exposed for spraying and harvesting.

Munson System.—This system, as shown in Fig. 19, is especially desirable r home vineyards where there are several varieties in the planting. It is easy r a person to cross from one row to another under the trellis. Spraying and arvesting are easily handled, and it is convenient to work and cultivate all ound and under the vines. It is possible to interplant small fruits such as urrants, gooseberries, and raspberries in the row between the vines. These

fruits are tolerant of shade and the trellis plan will permit it, which is an advantage in home plantings where the close utilization of available space is often desired.



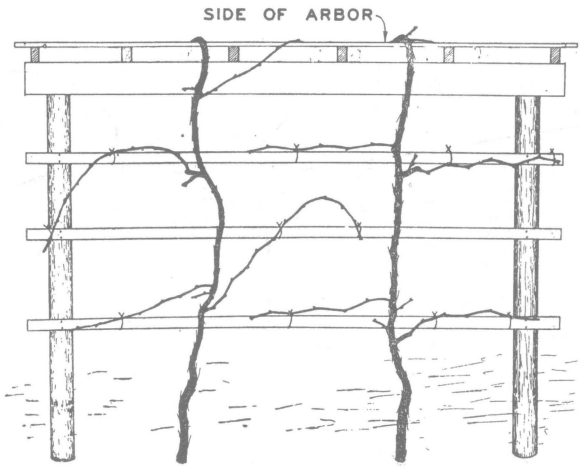


Fig. 20.—Where grapes are used to cover an arbor, relatively more wood is left to provide additional shade. A modification of the single-trunk Kniffin system of training to provide more canes is used as described in the diagram above. A renewal spur is left near the base of each cane.

The selection of the type of canes, arms, and renewal spurs is quite similar to that described for the Kniffin system, except that no arms are provided low on the trunk and all canes needed for fruiting are provided from short arms at the top of the trunk (see Fig. 19). Fruiting shoots are allowed to grow up between and droop over the two wires on the cross arms.

No summer tying is needed.

Wires can be attached to the wooden cross arms on the posts with staples, or set into slots sawed at the top and near the ends of the cross arms.

Arbors. — With arbors, a modification of the Kniffin system of training is followed (see Fig. 20), with the exception that the trunk is longer to cover the arbor and more arms are used to arrange the increased number of fruiting canes uniformly over the arbor.

More of the old wood is necessarily left on arbors after pruning than where vines are grown on a vineyard trellis. Usually, more fruiting buds are left after pruning, because the vines are

grown both for shade and fruit. For this reason, more small and scraggly bunches are harvested from vines trained over arbors than when properly trained on a trellis. However, with reasonably close annual pruning, as suggested in the diagram plan, Fig. 20, it is possible to secure very satisfactory yields and quality from grapes trained on an arbor.

Pruning Neglected Vines

Where pruning has been neglected for a year or more with mature vines, they become very rangy, with too much old wood. The best fruiting wood will be found a long distance from the trunk or base of the vine. Remove as much old wood as possible, then cut back the trunk and arms as far as possible to a point just above four to six reasonably desirable canes for fruiting. After two or three years of renewal pruning, neglected vines can be brought back within bounds to a fairly manageable pattern. If neglected vines are dehorned (cut back to 2- to 4-foot stubs) there are no canes left for fruiting, and it will take a year or two to obtain satisfactory canes. It is usually best to prune neglected vines to a pattern approaching some modification of the Fan system (see Fig. 18).

COST OF GROWING GRAPES

Labor and material costs in Ohio vary from season to season and from one location to another. The following cost-account table is given only as a guide for the grower in computing his own costs. The figures, which are from a group of Concord grape growers in northern Ohio, are based on the relatively good-crop year of 1937, when prices were somewhat more stable than those in War or Post-War periods. The average yield was 2½ tons per acre under average vineyard management. With yields of 3 to 6 tons per acre often possible with continued good management, the cost per ton is proportionately reduced.

Labor was figured at the rate of 30 cents per hour in the costs shown in the following table, as this was the prevailing rate in this part of the Lakeshore grape belt in 1937. This cost was doubled or more in 1943 during war-time conditions and will vary from year to year, but the record will give the information on the number of hours of labor used per acre in growing an average 2½-ton yield of Concord grapes with average vineyard management.

The actual cost per ton from year to year will vary with the labor rate per hour, costs of supplies and equipment, and most of all on the yield of grapes harvested per acre. Low ton costs are only possible with high ton yields per acre.

Cost of Establishing 3-year-old Vineyard (per acre)

Material Cost—

640 vines @ $30.00 per thousand		$19.20
210 posts @ 32¢ each		67.20
Wire (3 strands—13,500 ft., 525 pounds, 11 gauge @ 75¢ per cwt.)		3.95
Braces for end posts		5.00
Fertilizer.first year	$1.75	
" second year	2.00	
" third year	1.00	
		4.75
Total material cost		$100.10

Labor Costs (Man labor at 30 cents per hour)—

Plowing, fitting, trenching (first year)		$10.00
Planting vines		7.00
Placing posts and wiring		15.00
Cultivation first year		4.00
" second year		6.00
" third year		12.00
Fertilization first year	$0.75	
" second year	1.10	
" third year	.50	
		2.35
Trimming second year		1.00
" third year		2.50
Tying—second and third years		5.00
Pulling pruned wood off wires and brushing—second and third years		1.50
		$66.35

Use of Land (valued at $100 per acre)—

5½ per cent interest and 1½ per cent taxes for three years		$21.00
Interest on $19.20 for 3 years at 6 per cent		3.46
Interest on $76.15 for 2 years at 6 per cent		9.14
Total overhead cost for 3 years		$ 33.60
Total cost for 3 years		$200.05
Credit for grapes harvested		10.00
Total cost		$190.05

Annual Cost After Third Year Based on 2½ Ton Yield

LABOR COSTS—

Trimming	$3.25
Pulling brush and burning	3.50
Tying	3.25
Repairing posts and wires (mostly labor)	3.00
Spring disking and plowing	4.00
Horse hoeing	2.00
Hand hoeing and applying fertilizer	2.00
2 cultivations	4.00
Fall plowing (1 furrow)	2.00
Picking (2½ tons @ 4¢ per basket)	8.48
Hauling to barn ($1.00 per ton)	2.50
Extra labor in harvesting	3.00
*Spraying—two applications at $3.25 per application for labor and machine	6.50
Drilling cover crop and fertilizer	1.50
Total annual labor cost	$48.98

MATERIAL COST—

250 lbs. sulfate of ammonia	$3.75
250 lbs. 4-10-6 fertilizer	3.15
Strings or wires for tying	1.00
*Spray material (2 applications @ $1.75 per)	3.50
212 baskets @ 5¢ each	10.60
2 bu. rye	1.50
Total material cost per year	$23.50

OVERHEAD COSTS—

Annual depreciation of vineyard based on 20 years of life.	$5.87
Annual interest and taxes on land (7 per cent of $100.00)	7.00
Total overhead cost per year	$12.87
Annual acre cost	$85.35
**Cost per ton (2½ tons per acre)	$34.14

* Number of applications will vary with the prevalence of insects and diseases in a given vineyard. It is probable that more than two spray applications per season will be used in the future in those vineyards where berry moth is a problem.

** Farm to market and selling costs are not included, since this varies considerably depending upon local marketing conditions.

HARVESTING AND MARKETING GRAPES

Stage of Maturity

A common mistake is to pick grapes too early. Poorly colored sour grapes on the market discourage later sales. Unlike other fruits, there is practically no increase in sugar and color in grapes after they have been removed from the vines.

Proper time for picking depends upon the particular use. For jelly-making the fruit should be picked relatively early in order to obtain a light clear jelly free from crystals. Grapes for table use are picked when color and flavor are at the peak and before berries shatter from the bunch, which varies considerably by variety. When picked for juice, allow grapes to hang until full maturity is attained. Best index for maturity is determined by tasting for full flavor and aroma. This comes only from experience. Other indications of maturity are browning and slight shriveling of the stems, ease of separation of the berries, browning of the seeds, and freeness of the seeds from the pulp.

Containers

Containers for the commercial vineyard should be ordered well in advance of the picking season. Small light-weight picking stands as shown in Fig. 21 should be prepared for each picker.

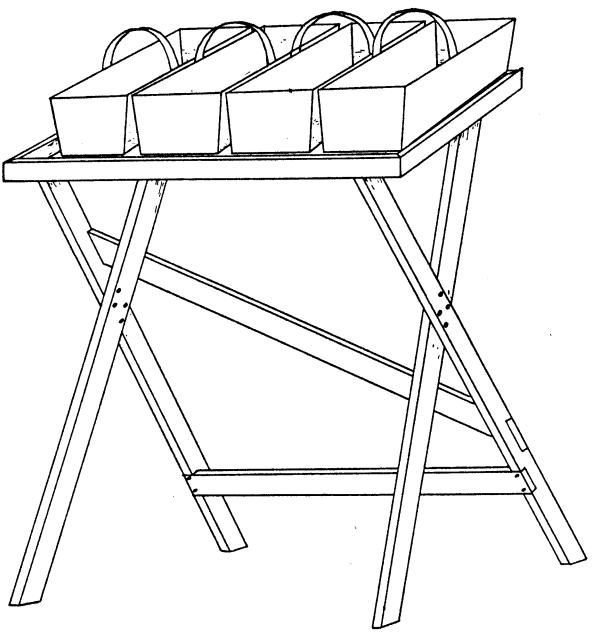


Fig. 21.—A light portable picking stand is convenient for filling baskets in the field. It should be about waist-high to prevent pickers from dropping bunches into the containers.

The Climax basket of the 2-, 4-, or 12-quart size is a popular style of container for the American type grape.

The wooden basket with wire handle, or, the cardboard basket with double or single weight walls and wooden handle are gaining in popularity in northern Ohio. The cardboard containers are light, somewhat more economical and better suited to advertising copy on the sides as shown in illustration (Fig. 22).

The 2- and 4-quart sizes of containers

are in common use for table grapes, whereas the 12-quart basket and the bushel or half-bushel basket are employed for juice purposes. The wooden lug box with outside dimensions of 24 inches in length, 12 inches wide and 6 inches deep, is used in large commercial areas where the fruit is sold for juice. The bushel basket is questionable for a container, even for juice purposes, as crushing of the berries and leakage often occur.

Fig. 22.—The 2-quart cardboard carton with wooden handle is a popular grape container. These snugly-packed cartons in a large retail Cleveland store are arranged *en masse* with alternating white and blue grapes to increase eye appeal.

Picking and Packing

Grapes for table use should be handled carefully from the time they are picked until sold. They should be handled by the stems and not pulled from the vines. Remove bunches with shears or a sharp knife. The better bunches are picked first and packed as Fancy or Number 1 grapes, whereas the imperfect bunches are picked later and packed as Number 2 grapes. In packing the basket, it is placed on the picking stand (see Fig. 21) in a slanting position and the corner nearest the picker is filled first with the stems pointing downward. The picker then proceeds to fill the basket from bottom to top until the corner farthest from the operator is filled. The baskets are carefully packed to about an inch above the rim, after which they are placed in the shade of the vine until taken to the shelter house, which should be as soon as possible. The grapes should be allowed to settle from 4 to 6 hours before tops are applied. Many baskets are sold, however, without tops.

For the higher grade grapes, the small, poorly colored, diseased, or insect-infested berries can be removed at picking and packing time, provided the current price will justify the extra labor. Cloudy dry days are best for picking. Decay is likely to occur if the grapes are picked wet.

◆ ◆

U. S. Standards for American (Eastern Type) Bunch Grapes

(Effective July 19, 1943)

Issued by the
WAR FOOD ADMINISTRATION
FOOD DISTRIBUTION ADMINISTRATION

INTRODUCTION

The tolerances for the standards are on a container basis. However, individual packages in any lot may vary from the specified tolerances as stated below provided the averages for the entire lot, based on sample inspection, are within the tolerances specified.

For a tolerance of 10 per cent or more, individual packages in any lot may contain not more than one and one-half times the tolerance specified.

For a tolerance of less than 10 per cent, individual packages in any lot may contain not more than double the tolerance specified.

GRADES

U. S. Fancy Table Grapes shall consist of grapes of one variety which are well colored, mature, firmly attached to capstems, not shattered, split, crushed, dried, wet or soft; which are free from mold, decay, mildew, berry moth, russeting, hail, and from damage caused by freezing, disease, insects, or other means. Not less than 50 per cent of the bunches in any container shall be compact and the remainder shall be fairly compact. Bunches shall not be excessively small, excepting that compact portions of bunches consisting of no less than five berries may be used to fill open spaces between whole bunches.

Berries of the Concord, Wordon, Champion, and other varieties of similar size shall have a minimum diameter of not less than nine-sixteenths of an inch, measured through the widest portion of the cross section.

In order to allow for variations incident to proper grading and handling, not more than a total of 10 per cent, by weight, of the berries in any container may fail to meet the requirements of this grade, but not more than 5 per cent shall be allowed for berries which are seriously damaged. Of this tolerance for serious damage, not more than one-fifth, or 1 per cent, shall be allowed for berries affected by mold or decay, and not over two-fifths, or 2 per cent, shall be allowed for dried berries or those affected by berry moth. In addition, not more than 5 per cent, by weight, of the bunches in any container may be straggly, and not more than one-tenth, by weight, of the bunches in any container may have more than 10 per cent of berries which do not meet the size requirement.

U. S. No. 1 Table Grapes shall consist of grapes of one variety which are fairly well colored, mature, firmly attached to capstems, not shattered, split, crushed, dried, wet or soft, which are free from mold, decay, berry moth, and from damage caused by mildew, russeting, hail, freezing, disease, insects or other means. Not less than 85 per cent of the bunches in any container shall be fairly compact.

Berries of the Concord, Worden, Champion and other varieties of similar size shall have a minimum diameter of not less than nine-sixteenths of an inch measured through the widest portion of the cross section.

In order to allow for variations incident to proper grading and handling, not more than a total of 10 per cent, by weight, of the berries in any container may fail to meet the requirements of this grade, but not more than 5 per cent shall be allowed for berries which are seriously damaged. Of this tolerance for serious damage not more than two-fifths, or 2 per cent, shall be allowed for berries affected by mold or decay, and not more than two-fifths, or 2 per cent, shall be allowed for dried berries or those affected by berry moth. In addition, not more than one-tenth, by weight, of the bunches in any container may have more than 10 per cent of berries which do not meet the size requirement.

U. S. No. 1 Juice Grapes shall consist of grapes of one variety which are fairly well colored, mature, firmly attached to capstems, not shattered, split, crushed, dried, wet or soft, which are free from mold, decay, berry moth, and from serious damage caused by mildew, russeting, hail, freezing, disease, insects or other means. Not less than 60 per cent of the bunches in any container shall be fairly compact.

In order to allow for variations incident to proper grading and handling, not more than a total of 15 per cent, by weight, of the berries in any container may fail to meet the requirements of this grade, but not more than 6 per cent, shall be allowed for berries which are seriously damaged. Of this tolerance for serious damage not more than one-half or 3 per cent, shall be allowed for berries affected by mold or decay, and not more than one-third, or 2 per cent, shall be allowed for dried berries or those affected by berry moth.

MIXED VARIETIES

Any lot of grapes consisting of more than one variety which meets all other requirements of "U. S. Fancy Table," "U. S. No. 1 Table," or "U. S. No. 1 Juice" may be designated as "U. S. Fancy Table Mixed," " U. S. No. 1 Table Mixed," "U. S. No. 1 Juice Mixed."

Unclassified shall consist of grapes which have not been classified in accordance with any of the foregoing grades. The term "Unclassified" is not a grade within the meaning of these standards but is provided as a designation to show that no definite grade has been applied to the lot.

DEFINITIONS OF TERMS

As used in these Standards:

"Mature" means that the grapes are juicy, palatable, and have reached that stage of development at which the skin of the berry easily separates from the pulp. Frozen, or slightly frosted stock should not be confused with mature stock.

"Well colored" means that the berries shall show full color characteristic of the variety.

"Fairly well colored" means that not less than 75 per cent, by weight, shall show full color characteristic of the variety. Twenty-five per cent may show partially or poorly colored berries which are not characteristic of immature berries.

"Shattered berries" means berries which have separated from the bunch.

"Compact bunches" means well filled bunches, with no open spaces.

"Fairly compact" means that the bunches are well filled but that the berries are not closely spaced as in "compact bunches."

"Damage" means any injury which materially affects the appearance or the edible or shipping quality. Mildew which affects the appearance of the berries shall be considered as damage, but berries shall not be regarded as damaged by mildew which are firmly attached to the stems and which have only slight traces of mildew on the inside of the bunch where it does not affect the appearance of the berries.

"Serious damage" means that the defects taken singly or collectively seriously affect the market quality.

"Straggly" means a decidedly open bunch with large open spaces and very few berries. Small immature shot-berries, characteristic of the Worden variety, should be disregarded unless they are excessive in number and detract materially from the appearance of the lot.

Issued June 16, 1943.

◆ ◆

U. S. Standards for American (Eastern Type) Bunch Grapes for Processing and Freezing

(Effective July 5, 1943)

Issued by the
WAR FOOD ADMINISTRATION
FOOD DISTRIBUTION ADMINISTRATION

GRADES

U. S. No. 1 shall consist of grapes of one variety which are well colored (1), mature (2), not crushed, dried or soft; which are free from mold, decay, berry moth injury, and from serious damage (3), caused by russeting, hail, freezing, mildew, other disease, insects or other means.

In order to allow for variations incident to proper grading and handling, not more than a total of 15 per cent, by weight, of the berries may fail to meet the requirements of this grade, but not more than 6 per cent shall be allowed for berries which are seriously damaged. Of this tolerance for serious damage not more than one-half, or 3 per cent, shall be allowed for berries affected by mold or decay, and not more than one-third, or 2 per cent, shall be allowed for dried berries or those affected by berry moth.

U. S. No. 2 shall consist of grapes which meet the requirements and tolerances of U. S. No. 1 grade except that they need be only fairly well colored (4) and except that not more than 3 per cent tolerance shall be allowed for dried berries or those affected by berry moth.

Unclassified shall consist of grapes which fail to meet the requirements of either of the foregoing grades. The term "unclassified" is not a grade within the meaning of these standards but is provided as a designation to show that no definite grade has been applied to the lot.

DEFINITIONS OF TERMS

As used in these Standards:

(1) "Well colored" means that not less than 90 per cent, by weight, of the berries show full color characteristic of the variety. Ten per cent may show partially or poorly colored berries which are not characteristic of immature berries.

(2) "Mature" means that the grapes are juicy, palatable, and have reached the stage of development at which the skin of the berry easily separates from the pulp. Frozen or slightly frosted stock should not be confused with mature stock.

(3) "Serious damage" means any injury or defect which seriously affects the processing or freezing quality.

(4) "Fairly well colored" means that not less than 75 per cent, by weight, of the berries show full color characteristic of the variety. Twenty-five per cent may show partially or poorly colored berries which are not characteristic of immature berries.

Issued June 1, 1943.

MARKETING

Grapes should be taken to market on the day they are picked or not later than the next day. The less they are handled from picking until they reach the consumer, the better. If the vineyard is located near a main highway, it is possible to dispose of a portion of the crop by selling from a roadside stand. Some growers save on container costs by removing the grapes from the cartons and placing them in paper bags for the customer. Some large retail stores have been known to cooperate in the same procedure, and return the majority of the containers for second or third use. It is true, however, that the baskets tend to hold slightly more fruit when used more than once.

If competition is keen in a given season and labor costs are not too high, it may prove profitable to mix red, white, and blue grapes in the basket at the packing shed. The return for this packing is often about 5 cents more per quart basket, which is more than five times the labor cost involved. In season, another venture is to mix apples, pears, peaches or other fruits with the grapes in 2-quart containers. This makes an attractive family package.

STORAGE OF GRAPES

Occasionally it is desirable to store grapes if they cannot be used immediately. Only the Fancy or Number 1 grapes which are in sound condition should be placed in common storage (45 to 60° F.), or cold storage (30 to 35° F.), with the humidity about 85 per cent. The containers should be stacked with frequent isles, running both vertically and laterally, to provide for free air circulation. To reduce mold development, it is a common practice to spray the storage room and picking boxes with a solution of 2 pounds copper sulphate in 50 gallons of water before picking starts.

The storage season of grapes is short as compared with apples, usually not more than one to two months. Good keeping varieties are Delaware, Diamond, Caco, Agawam, Catawba, Sheridan, and Vergennes. In general, the red grapes are better keepers than the black, white, or blue varieties.

GRAPE INSECTS AND DISEASES, AND THEIR CONTROL

By T. H. PARKS, Entomologist
C. C. ALLISON, Plant Pathologist
Agricultural Extension Service, The Ohio State University

THE GRAPE is attacked in Ohio by a number of insects and diseases which are capable of causing heavy loss. However, on the average farmstead, grapes of fair quality are sometimes grown without any spraying treatment being given them. This is especially true where judicious yearly pruning is practiced and where vines are kept in a vigorous growing condition.

Insect and disease problems vary in different vineyards. Therefore, the control measures employed must depend on the conditions present. As a result, it is impossible to construct a spray schedule for grapes that will have general application.

In considering the spraying of the vineyard, it seems desirable to consider the quality of the crop previously produced and the type of insect or disease injury, if any, which was present. The injury may be due to a single insect or disease which results in a definite type of damage to the fruit or vine. If one

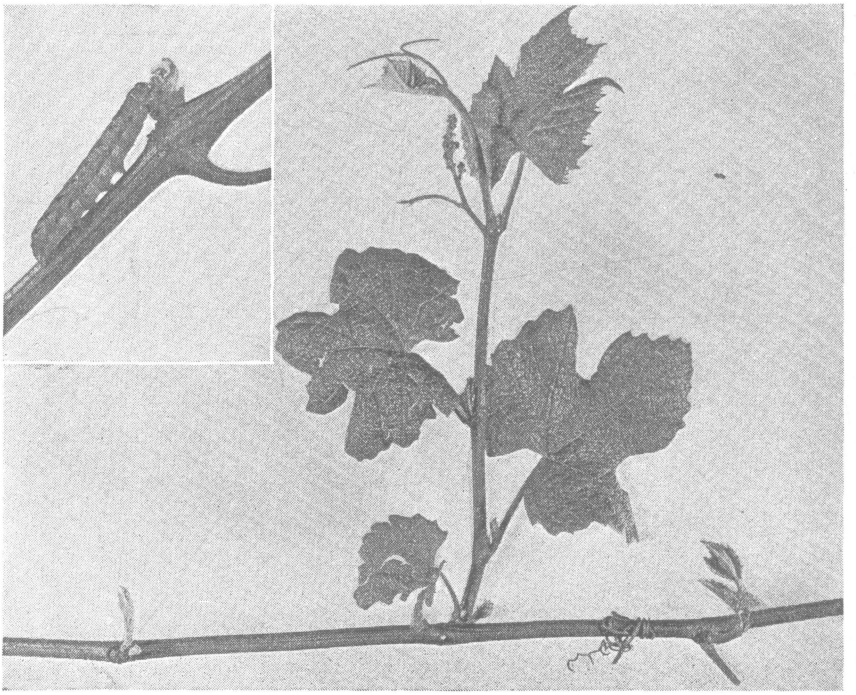


Fig. 23.—(Insert) Climbing cutworms are capable of destroying many grape buds in spring. (Below) Center shoot shows normal growth from a primary grape bud, but to the left and right the primary buds have been destroyed by climbing cutworms, which feed at night. Yield from secondary shoots is greatly reduced.

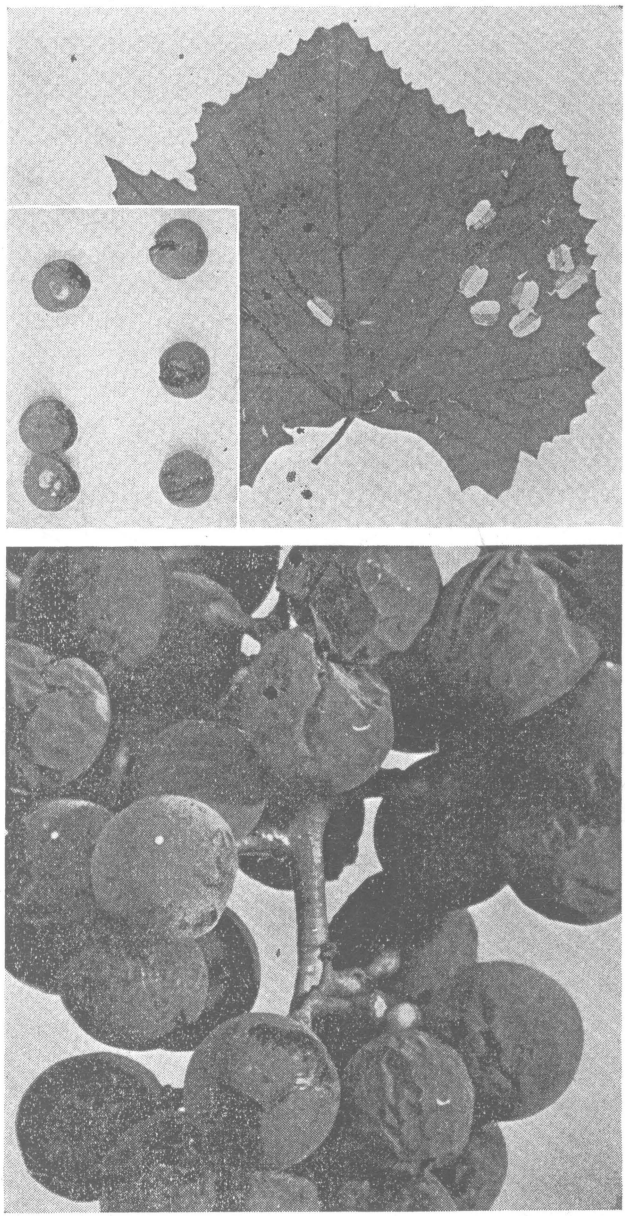


Fig. 24.—(Above) The green berries in the insert have been split open by berry worm injury early in the growing season. The dead leaf contains 8 berry moth cocoons and was taken from beneath the vines in autumn. If these leaves are covered by soil in early spring as shown in Fig. 8, it is difficult for berry moths to emerge and lay eggs. (Below) Mature berries which show shriveling due to berry worm injury late in the season. Webs, cracking, and considerable frass are present.

or more of these troubles persist in appearing each year, the spray or sprays designed to correct that trouble should be used (see Tables, pages 39 and 40). Thorough applications made at the proper time will usually result in producing grapes of good quality.

At the western end of the Lake Erie grape belt, black rot, mildew, berry-moth (wormy berries), and leaf-hoppers constitute the usual pests. In northeastern Ohio, black rot, berry-moth, leaf-hoppers, and root worms largely determine the spraying program used. In southern counties, black rot and berry-moth frequently contribute to serious grape losses. Not all of these pests are likely to be troublesome in any one vineyard during the same year. A few

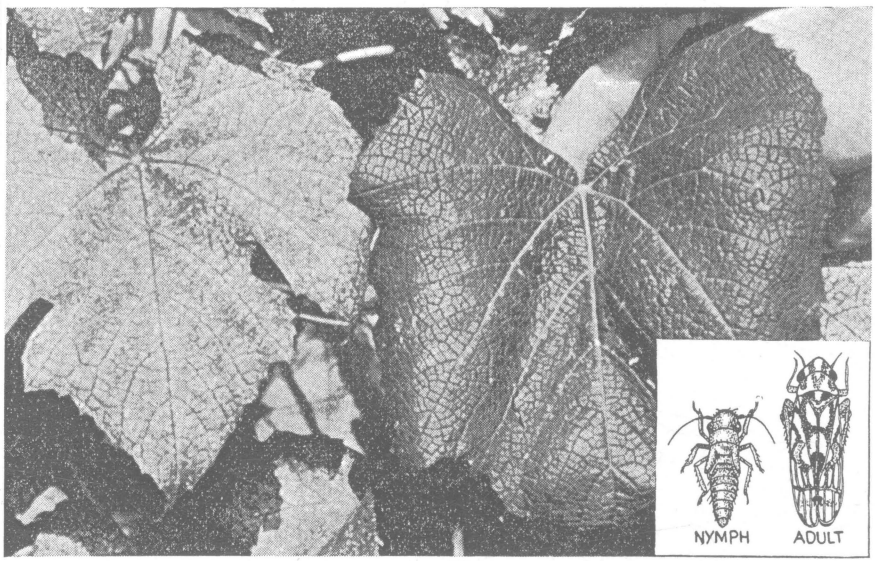


Fig. 25.—Grape leaf on the left has been fed upon by a large population of leafhoppers; the one on the right was taken from a vine sprayed at proper intervals with nicotine. In the lower right corner are the nymph and adult grape leafhopper; the adult is about ⅛-inch long.

of them appear each year in the commercial grape growing area in northern Ohio, where the extensive grape culture in that area promotes their abundance (see Figs. 24 and 25).

Black rot and mildew (see Figs. 26 and 27) are most destructive during seasons of humid weather. If the early sprays are omitted, black rot may increase greatly from year to year, until the carry-over is so great that the whole crop may be destroyed. Vineyards partially surrounded by woods in such a way as to prevent air drainage are likely to have black rot problems. Likewise, grape berry-moth is always sheltered during the winter by adjoining woods, making the control of this pest difficult for a width of several grape rows nearest the woods. It is best that the grape plantings NOT be made next to a woodland area.

Pruning grape vines and prevention of tall weed growth under and near the wires allow more rapid drying of foliage and fruit clusters. This aids in controlling diseases and promotes better coverage with spray materials.

The accompanying insect and disease calendar aims to cover the principal insects and disease enemies of grapes. The vineyard owner is advised to study this calendar. From the description of the insects and diseases he should be able to pick out the spray or sprays needed to control his existing trouble. In order to reduce production costs, it is essential that the grower apply only such sprays as are *actually needed* to protect his fruit and to so adjust his cultural and pruning practices as to aid in insect and disease control.

CALENDAR OF GRAPE INSECTS AND DISEASES

With Remedy and Spray Recommendations Suitable for Small Plantings

Insect or Disease	Description	Remedy or Prevention	When to Appl
Grape Berry-moth	Small brown worms which develop in fruit, causing it to color prematurely. Infested berry later cracks open or shrivels and drops from bunch.	Spray fruit with lead arsenate 4 level tablespoons in 1 gal. of water with soap spreader. This is 1 pint to 8 gals. Combine with 4-6-100 bordeaux if disease is present (see table, p. 46). Repeat above 10 days later.	1. Just after bloon (No. 2 under rot.) 2. Ten days later. 3. See schedules p and 40.
Grapevine Flea Beetle	Small, steel-blue jumping beetles that eat the opening buds in spring and destroy the new cane and fruit. The dark brown larvae feed on upper surface of the leaves in June.	Beetles are difficult to control. Hold a large pan of water containing a film of kerosene under canes and gently tap them; beetles will drop *or* Spray as for rose chafer if beetles are seen on buds. Spray foliage with lead arsenate, 4 tablespoons to 1 gal. water (1 pint to 8 gals.) to kill larvae.	When beetles are n In May. In June when gru feeding.
Grape Root Worm	Small, grayish-brown beetles which eat chainlike marks in the upper surface of leaves in June and July. Larvae feed on roots of grape.	Spray foliage with lead arsenate, 5 level tablespoons to 1 gal. water (1 pint to 6 gals.) late in June before the first feeding marks are observed. Direct spray against upper surface of the leaves.	In June when f marks are first n
Rose Chafer	Long-legged, yellowish-brown beetles about ½ inch long. Eat blossom buds, newly set fruit and foliage. Limited principally to sandy areas of vineyards.	Hand picking is practical on a few vines. Spray with strong lead arsenate, 5 level tablespoons to 1 gal. water, sweetened with sirup (1 pint lead arsenate to 5 gals. water).	When beetles ar noticed.
Climbing Cutworms	Brown cutworms that hide on the ground near canes by day and feed at night on the opening buds in April or early May.	Apply poisoned bran mash and place bands of cotton batting or tree tanglefoot around post and cane.	As soon as dam noticed in Ap early May.
Leafhopper	Very small elongate pale green insects marked with yellow and red, which jump from the leaf when disturbed. Suck the sap from underside of leaf. Cause speckled or rusty appearance of leaf.	Spray insects with nicotine sulfate. 1½ teaspoons to 1 gal. soapy water or bordeaux mixture (see page 40). Spray underside of leaves *or* Dust with nicotine dust containing not less than 3 per cent nicotine. Keep down tall grass about grapevines.	When noticed and hoppers have oped wings. Best time is ab weeks after bloc Repeat in 10 d necessary.
Black Rot	Fruit rots, blackens, shrivels, and is covered with black dots. Leaves with brown spots having gray centers and many black dots.	Spray with bordeaux mixture 4-6-100 (see pages 40 and 46). Include insecticides in 2nd and 3rd applications.	1. Just before b buds open. 2. Just after bl fall. 3. Ten days later berries are the B-B shot.
Downy Mildew	Leaves with indefinite yellowish areas above; white downy patches beneath. Young shoots covered with white, downy growth.	Same as for Black rot.	See Black rot.

GRAPE SPRAY PROGRAM

Commercial Vineyards having a serious Berry-worm or Black Rot Problem)

ME AND TIME OF SPRAY	MATERIALS TO USE	TO CONTROL	FURTHER SUGGESTIONS
Dormant buds show ½ to h green	6-8-100 bordeaux mixture (see page 40). *and* Rosin fish oil soap[1].....2 lbs. Kerosene .....½ pint (125 gals. per acre)	Black rot	In localities where black rot has been serious. Watch out for injury to buds by climbing cutworms (see page 38). To aid in the control of berry-moth worm, plow to vines as soon as soil can be worked. Plow under all fallen leaves and trash in which cocoons are located. Do not work soil again until 10 days after bloom.
som e blossom buds When the new are 10 to 12 long.	6-8-100 bordeaux mixture *and* Rosin fish oil soap[1].....2 lbs. Kerosene .....½ pint (150 gals. per acre)	Mildew Black rot	Needed where these diseases occur. Cover all leaves and bud clusters. Watch for rose chafers which may appear just before bloom and destroy blossom buds. If they appear, spray with 8 lbs. lead arsenate and 2 gals. of molasses in 100 gallons of bordeaux or water.
erry-moth before bloom)	Same as petal-fall spray	Berry-moth Black rot Mildew	Necessary in years when early emergence occurs and considered as good insurance in vineyards heavily populated with berry-moths.
ll ediately after ming)	4-6-100 bordeaux mixture *plus* Lead arsenate.....3 lbs. *and either* Rosin fish oil soap[1].....2 lbs. Kerosene .....½ pint *or* Summer spray-oil .....3 qts. (200 gals. per acre)	Berry-moth Mildew Black rot Leafhoppers (see under suggestions)	Very important where berry-moth is serious. If very young leafhoppers are numerous on the underside of the leaves, add ¾ pint of nicotine sulfate and, with high pressure, force the spray against underside of leaves.
Spray to 10 days after fall spray.	Same as for petal-fall spray. Fixed booms should have one nozzle at top directing spray downward on leaves. (200 gals. per acre)	Berry-moth Root beetle Black rot Leafhoppers (see under suggestions)	Very necessary where berry-moth is serious. If young leafhoppers are numerous apply nicotine sulfate as directed under previous application. Soil plowed for berry-moth control can now be worked down.
Brood Spray grapes first in clusters (late uly or early in st)	2-4-100 bordeaux mixture *plus* Lead arsenate[2].....3 lbs. *and either* Rosin fish oil soap[1].....2 lbs. Kerosene .....½ pint *or* Summer spray-oil[1] .....3 qts. (250 gals. per acre)	Berry-moth Black rot	This spray must be driven against the fruit clusters. Dense foliage makes it difficult to secure good coverage except by hand operated spray nozzles. Calcium arsenate can be used instead of lead arsenate but has caused foliage injury at times. It should not be used with summer oil.

sin fish oil soap is the best sticker and spreader. It should be mixed alone in a bucket of hot water and o the spray tank LAST with agitator going. Since its use frequently results in excessive foaming in the e kerosene is added immediately to reduce this foaming. Other spreaders and stickers, such as fish oil, soap, soap flakes, or casein-lime may be used, but are inferior to rosin fish oil soap. Summer spray-oil formed well in recent years when tested for berry-moth control and is more widely available than rosin soap. Most summer oils require that a material such as Dreft (3 ounces) be added to give them suitable properties and make the droplets spread over the grapes. Consult your county agent for available is.

though a heavy spray of arsenical and bordeaux mixture applied to grape clusters, either the last week or the first week in August may give fairly good control of the second brood of berry-moth larvae, some danger of too much residue if grapes are to be marketed as fresh fruit. Where mid-August sprays nd brood berry-moth are needed, fixed nicotine sprays offer a possibility. These should carry 3 pounds of eaf 155 (14%) and either ½ pound of rosin fish oil soap, or 2 ounces of Dreft (a commercial soap) to 0 gallons. Bordeaux mixture or lime cannot be used with the fixed nicotine. Two August sprays, spaced to 10 days apart are suggested. The first of these should be timed to immediately precede the first hatch- econd brood berry-moth eggs, the time varying with the season and locality.

GRAPE SPRAY PROGRAM

(For Commercial Vineyards not having a serious Berry-worm or Black Rot Prob

NAME AND TIME OF SPRAY	MATERIALS TO USE	TO CONTROL	FURTHER SUGGESTIONS
Pre-blossom Before blossom buds open when the new shoots are 10 to 12 inches long	6-8-100 bordeaux mixture (see below) (150 gals. per acre)	Mildew Black rot	Watch for rose chafers which m vour the buds before blossoms ope If rose chafers are eating the add 8 lbs. lead arsenate and 2 g molasses to 100 gals. of spray.
Petal-fall (Immediately after blossoming). Three to 5 days after the fall of the bloom	4-6-100 bordeaux mixture *plus* Lead arsenate.....3 lbs. *and either* Rosin fish oil soap[1].....2 lbs. Kerosene .....½ pint *or* Summer spray-oil[1] .....3 qts. (200 gals. per acre)	Berry-moth Mildew Black rot	Prepare the bordeaux in spray Dissolve the soap in hot wate add it to bordeaux and lead mixtu agitator going. The kerosene i added to prevent rosin fish oil soa foaming in the tank. If summer spray-oil is used spreader, add it last while agit going (see note No. 1, page 39).
Repeat Spray 10 days after petal-fall spray	Same as for petal-fall spray. (If summer spray-oil is used here it results in the grapes having a dull finish when mature.) (200 gals. per acre)	Berry-moth Root beetle Black rot Leafhoppers Mildew	Be sure to cover fruit cluster as the upper surface of the leaves If young leafhoppers are numer the undersides of the leaves, add of nicotine sulfate and, with hig sure, force the spray against un of leaves.
Special Leafhopper Spray (Early in June before the first leafhoppers develop wings.)	Same as petal-fall spray, except that 1 pint of nicotine sulfate is added. If berry moth has been controlled the lead arsenate can be omitted.	Leafhoppers	This special spray is sometimes sary in order to control leafhoppe prevent "rusty" foliage. Direct insects on the underside of the le advised in previous spray.

[1] One of these materials is necessary as a spreader in this and the later sprays. Laundry soap can b stituted but is more difficult to dissolve. (See note No. 1, page 39). The kerosene is added to prevent rosin soap from foaming in the tank. It should be used only with rosin fish-oil soap.

BORDEAUX MIXTURE

Bordeaux mixture is an excellent fungicide and carrier for insecticides used in grape sprays. It is safe to use on the common varieties of grapes and prevents burning from arsenate of lead. Where bordeaux is not used as a carrier for the arsenical, it is advisable to add hydrated lime to the water at the rate of 3 pounds to 50 gallons of water. The lime should be freshly hydrated and preferably a specially fine high calcium spray lime.

Bordeaux mixture is spoken of as 4-6-100 and 6-8-100. This means (for the first mentioned) 4 pounds of blue vitriol and 6 pounds of fresh hydrated lime used in each 100 gallons of water. The weaker strength is used in the after-bloom sprays, as the stronger mixture sometimes causes foliage injury. There are two general methods now in use for preparing bordeaux mixture. The standard method is Method I, as follows:

Method I.—Prepare a stock solution of copper sulfate by dissolving the required amount of copper sulfate in the ratio of 1 pound to 1 gallon of water. To do this, always suspend the copper sulfate crystals in a sack submerged just beneath the surface of the water. The warmer the water, the more rapidly the crystals will dissolve, but they will dissolve in moderately cold water in a few hours.

The stock hydrated lime is prepared by making a lime paste of known strength which can be washed into the tank through a screen, or a stock

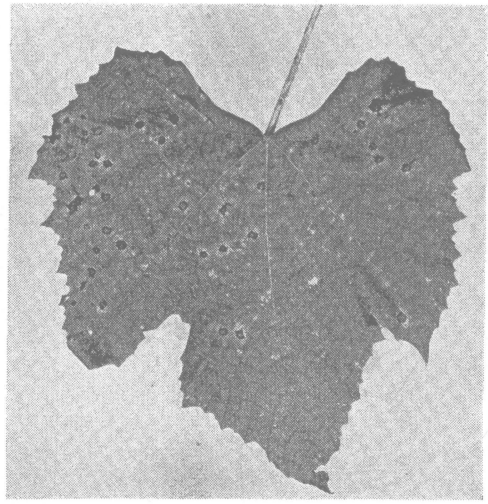
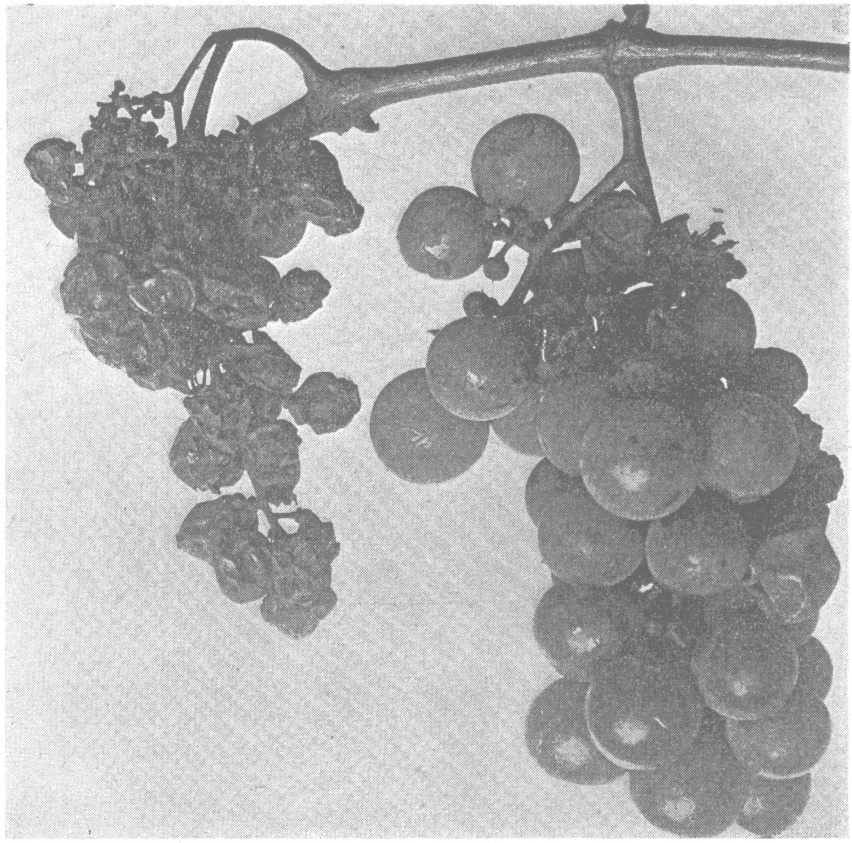


Fig. 26.—(At left) Black rot appears on leaves during rainy periods in June and July. Spots are small, somewhat translucent in center, browning toward outside, with concentric rings, pin-head black pimples, and a black-line margin encircling the spot.

(Below) Berries infected with black rot shrivel into hard black mummies which are covered with numerous tiny pimples. Many of these shell and fall to the ground.



solution may be prepared in a barrel by mixing 2 pounds of lime with each gallon of water. If a good grade of freshly hydrated lime is available it may be sifted directly into the tank.

To fill a 100-gallon tank with a 4-6-100 bordeaux mixture, fill the tank two-thirds full of water, and start the engine to keep the agitator running. Mix the 6 pounds of hydrated lime into a cream and pour through a strainer into the tank; *when thoroughly mixed* add the 4 gallons of copper sulfate stock solution. Complete the filling of the tank to 100 gallons. If lead arsenate is to be used it should be added, and lastly (if necessary) the spreader, which has previously been dissolved.

Method II.—The second method is the preparation of instant bordeaux mixture. Recently, copper sulfate has been manufactured in what is known as snow form, which dissolves quickly. No stock solution, therefore, is necessary. The mixture is made as follows: Fill the tank half full of water and, with the agitator running, wash in the hydrated lime through the screen. Next fill the tank two-thirds to three-fourths full, place the copper sulfate snow on the screen and wash through, and then completely fill the tank.

Spreaders

When spraying grapes to control berry-moth worms, it is necessary to include a spreader and sticker to enable the spray to adhere to the waxy coating of the grape and to the bodies of the leafhoppers. Many materials have been tried, but rosin fish oil soap has been found most suitable. Two pounds of rosin fish oil soap dissolved in hot water are added to each 100 gallons of spray material. It should be added last, with the agitator going. The small amount of kerosene, recommended in the spray schedule to be used with the rosin fish oil soap, is for the purpose of preventing the material from foaming in the spray tank, and should be added immediately after the fish oil soap. This mixture does not injure fruit or foliage.

For commercial vineyards, mineral oils, sold for summer use on apple foliage, have been found to be satisfactory if a small amount of suitable wetting agent is added to make the spray droplets spread over the surface of the grape berry. Dreft, which is a commercial soap product, is one now widely obtainable and, when used at the rate of 3 ounces per 100 gallons of spray, results in the oil covering the surface of the fruit before the spray dries. Some summer oils have a suitable wetting agent incorporated in them. This is very important and may determine success or failure to control grape berry-moth. While 2 quarts of summer oil per 100 gallons is sufficient for use as a spreader and sticker, 3 quarts per 100 gallons are recommended, because at this strength the oil kills all berry-moth eggs with which it comes in contact.

The use of summer oil with bordeaux mixture against the second brood of worms leaves the grapes carrying much spray residue at harvest time. Attempts to remove spray residue by washing the grapes is not considered practical and cannot be recommended.

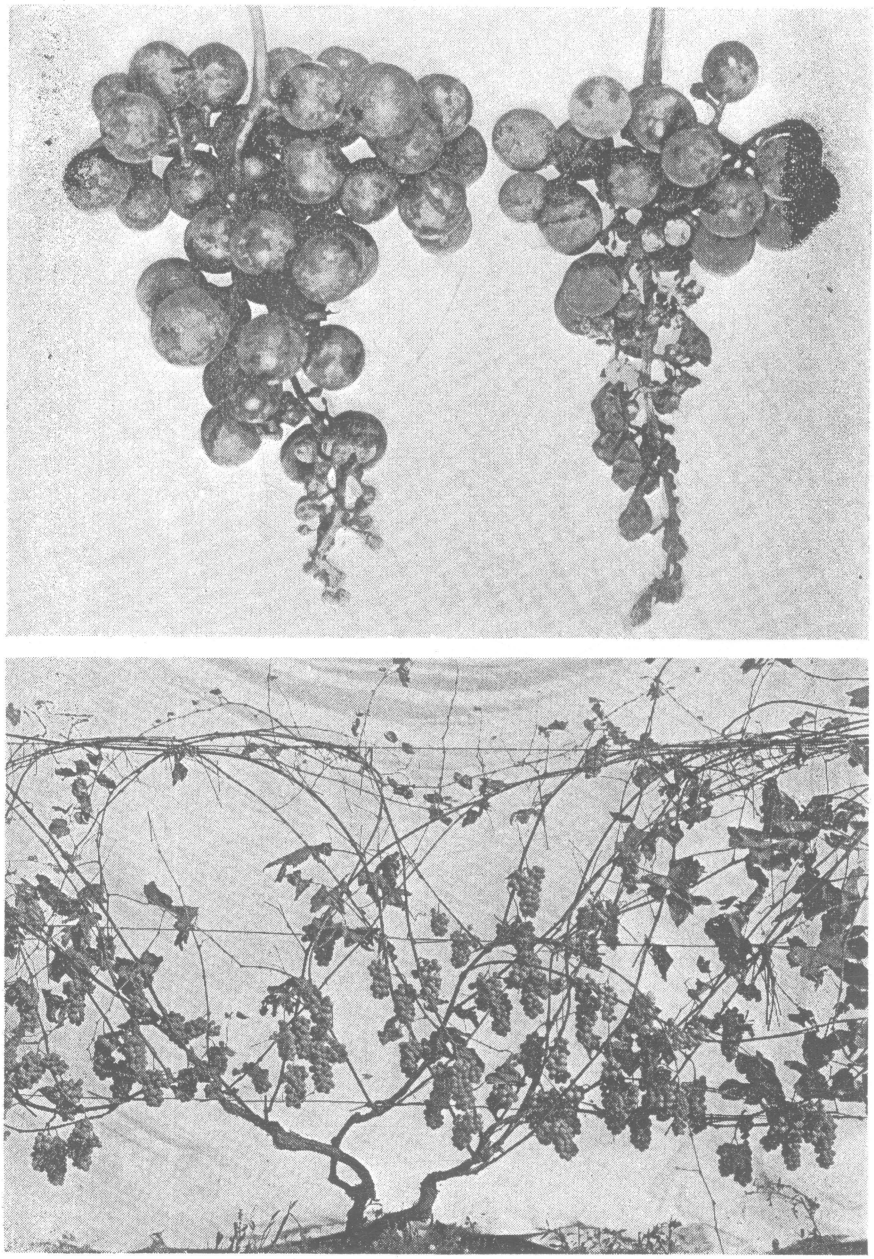


Fig. 27.—(Above) Downy mildew may attack berries when young or almost mature; if young, the berries cease development and show a grey mold on surface; if almost mature, they shrivel, dry completely and turn brown. (Below) Downy mildew appears on foliage as translucent or "oily" spots on upper surface and as milky-white mold on under surface. In severe cases, the foliage drops early and results in poor size, color, and flavor of fruit.

The grape berry-moth pupae over-winter on the ground in cocoons made by the folding and rolling of grape leaves (see Fig. 24). These cocoons are found under the vines. From these cocoons the adult insects (moths) emerge over a considerable period of time, but in greatest numbers while the grapes are in bloom and for about 2 weeks thereafter.

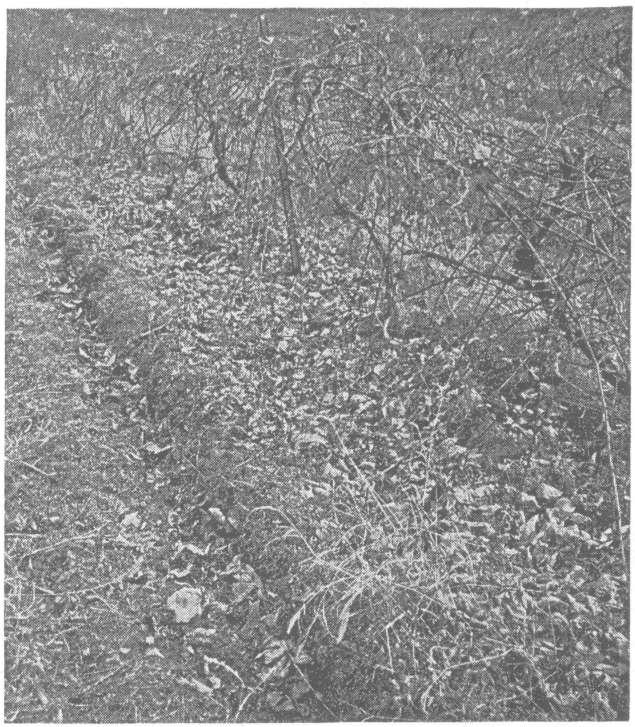


Fig. 28.—Fallen leaves under the wire show where berry-moth larvae pass the winter. Most of the cocoons are within a 12-inch strip under the wire near where the wormy berries dropped.

Experiments carried out at Sandusky, Ohio, showed that where these cocoons were buried under a comparatively shallow soil covering (see Fig. 6), practically no emergence of moths resulted. This inability of moths to emerge from buried cocoons indicates that this method can be put to practical use in commercial vineyards. Tests made during the past 10 years show this to be a valuable supplementary method to reduce the number of first brood moths. The method is suggested for vineyards previously showing a heavy infestation.

To carry out this idea, the ground should be kept cultivated during the summer but cultivation discontinued after August. No further cultivation is made until spring, the berry-moth cocoons being left unprotected on the soil surface under the vines. A plow or grape hoe is used in the spring so that the operation completely covers all of the earth and old leaves under the wires. Do not again disturb until 2 weeks after bloom, which is after the normal period of moth emergence. The soil can then be cultivated away from vines and later seeded to a cover crop (see back cover).

In those vineyards which require surface drainage during the winter, the plowing to the wires can be done late in the fall after the grape harvest has been completed.

During the time a vineyard is coming into production and even during the arly years of bearing, there is frequently no spraying required. As the vines ecome older, diseases and insects are likely to make regular spraying necessary. Rows must be spaced at least 10 feet apart and judicious pruning and tying f vines must be followed where power sprayers are used.

Where spraying is necessary, adequate equipment should be provided. For ommercial plantings this consists of a gasoline power sprayer of suitable capacty, capable of delivering the spray under pressure of 250 pounds or higher. From 150 to 250 gallons of spray per acre are required for proper coverage.

Either the fixed boom or the trailer method may be followed. If a fixed oom is used, it should be so constructed and fitted as to cover both sides of the ame row simultaneously. These booms are fitted to the sides of the sprayer and re usually equipped with 7 nozzles. Three nozzles direct the spray against ach side of the row and one from above. The upper nozzle may be closed

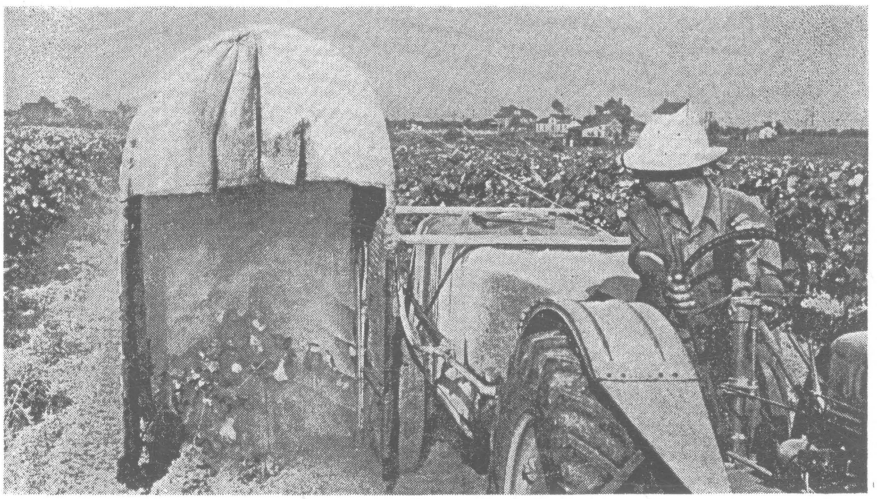


Fig. 29.—The covered boom affords good spray coverage on grape foliage and fruit. It is particularly effective in trapping and covering leafhoppers, and can be used effectively on windy days.

n the early sprays, but is very essential in the after-bloom sprays. The fixed oom reduces the labor required and is both rapid and efficient. If the fixed oom is covered with a canopy to hold the spray as a fog it results in better overage and wastes less material (see Fig. 29).

Some growers prefer to operate the nozzles by trailing the sprayer and praying one side of a row at a time. This method enables the operator to hange the course of the spray at will and give special attention to the fruit lusters. It requires more hand labor and is a slower method, but is effective n the hands of a careful operator. Where the foliage is very dense and heavy, and operation of the nozzles gives the best coverage of fruit clusters.

Regardless of the method followed, only thorough work will control.

Suggestions for Spraying Home Plantings

The equipment suitable for home plantings, where only a few grapes are to be sprayed, is a good hand sprayer of barrel or bucket type that will deliver the spray under sufficient pressure. Prepared bordeaux mixture may be used if desired, as the amount required will not make the expense prohibitive.

Dilutions of spray materials for quantities needed for home plantings are as follows:

Material	25 gallons of spray	10 gallons of spray	5 gallons of spray
Bordeaux mixture 4-6-100			
Copper sulfate	1 lb.	6 oz.	3 oz.
Lime	1½ lbs.	2 cups	1 cup
Lead arsenate	¾ lb.	1½ cups	¾ cup
Nicotine sulfate	4 oz.	3 tablespoons	5 teaspoons
Spreader:			
Fish oil soap	½ lb.	3 oz.	1½ oz.
or			
Laundry soap	1¼ bars	½ bar	¼ bar
or			
Summer spray-oil	1½ pints	½ pint	4 oz., or 9 tablespoons
and			
Dreft (a prepared soap)	½ oz.	Pinch	Pinch

Where grape diseases only are to be combated, a prepared fungicide dust may be applied to the foliage with a hand duster. The proper dust to choose is 20-80 copper-lime dust, which can either be purchased ready mixed or mixed at home. It should be dusted on while the foliage is wet with dew. Dust applications against grape insects have not proved satisfactory, because of their poor adhesive qualities.

Protect Grapes by Bagging

Where only a few grapes are grown, and high quality is desired regardless of expense, bagging the fruit clusters with heavy paper bags while the berries are half-grown is a method that can be followed. This results in protecting the berries against the larva of the berry-moth during the period of the second brood, from late in July to harvest time. Bagging does not protect against other grape pests.

Since grapes do not require sunshine to develop color, their finish is not impaired but actually improved by bagging. The bag must be applied just before the grapes touch in the cluster and the top lapped and fastened closely around the stem at the base of cluster by means of a wire paper stapling clamp, or securely tied with a string. Rubber bands deteriorate and break the seal. Bagging should not be considered as a commercial venture because of the labor and expense involved.

ACKNOWLEDGMENTS

◆ ◆

T. L. White, grape grower, Chardon, Ohio, contributed suggestions on grape marketing practices.

Drs. J. H. Gourley and W. P. Judkins, of the Ohio Agricultural Experiment Station, gave many constructive contributions.

George Still, in charge of the U. S. Department of Agriculture Grape Insect Laboratory, Sandusky, Ohio, contributed constructive suggestions on the Spray Calendar.

Dr. N. F. Childers, Department of Horticulture, Ohio State University, gave valuable assistance in preparing illustrations and portions of the manuscript.

ILLUSTRATIONS

The authors are indebted to the following for their courtesy in supplying the illustrative material mentioned below:

Figure 4, courtesy of the U. S. Department of Agriculture, Soil Conservation Service.

Figure 7 (upper photo), courtesy of the Syracuse Chilled Plow Company.

Figure 7 (lower photo), courtesy of the Ajax Flexible Coupling Company.

Figures 22, 24 (lower photo), 26, 27, and the back cover page, courtesy of the American Fruit Grower.

Figure 25 (leaves), courtesy U. S. Department of Agriculture Grape Insect Laboratory, Sandusky, Ohio.

Figure 28, courtesy of the U. S. Bureau of Entomology and Plant Quarantine.

Figure 29, courtesy of the Tobacco By-Products and Chemicals Corporation, Inc.